telephony

OCTOBER 8, 1979

THE JOURNAL OF THE TELEPHONE INDUSTRY SINCE 1901

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Is a satellite toll network feasible for rural telephony?

Small Independent telcos must protect their largest source of revenue—providing message toll service to and from their exchanges. Here's a look at how that can be done

Gerald S. Schrage and John N. Rose

FOR THE average REA (Rural Electrification Administration) financed telephone system, toll revenue accounts for 57% of total revenues. Clearly, small Independent telephone companies need to protect their largest source of revenue—providing message toll service (MTS) to and from their exchanges.

Until recently other common carriers (OCCs) competed mainly in the private line point-to-point communications market. The OCC competition was limited mainly to urban intercity routes and primarily affected the Bell System and some of the larger Independent telephone holding companies. The Bell System, not the OCCs, is the competition in the rural areas. AT&T (American Telephone & Telegraph Co.) and its associated companies through the provision of private line services, private line network services and other alternate services had provided most of the competition to small Independent company message toll services. Even with the Bell competition, toll revenues have grown rapidly.

Now, however, with the introduction of Execunet type services by the OCCs there will be the possibility of increasing diversion of Message Toll System (MTS) traffic and possible subsequent reduction or less growth in MTS revenues for both the large urban based telephone systems as well as the small rural Independent telephone systems. AT&T also is making an effort to compete with the OCCs by offering improved private network service. This spells more competition for the rural based telephone system. Even if the competition to message toll and WATS (wide area telephone service) is not directly in the rural areas, it will indirectly affect toll revenues by lowering or limiting the growth of the toll pool which all telephone companies share.

The direction of the pending legislation in Congress is toward unregulated competition and away from the present regulated environment and its associated uniform toll rates. If these bills become law, toll revenues will generally be reduced more for rural telephone systems.

Because new technology may be applied to reduce costs, the REA decided to look into the possibility of a satellite toll network for borrower central offices. The purpose of the study was to determine if new technology could be applied in rural areas to prevent a raise in toll rates on rural routes if competition and legislation should require deaveraging of nationwide uniform toll rates.

The approach was to find ways of retaining more of the toll revenue on the resultant traffic. Various combinations of satellite and terrestrial microwave trunks were substituted for the present outgoing DDD (direct distance dialing) network and its related Ozark toll settlement procedures. The result is probably what most people already suspected but could not prove; at this time there are few opportunities for the REA borrowers to diversify out of the existing DDD network arrangements to carry MTS traffic. However, the REA borrowers should continue to periodically monitor the situation as the feasibility could change as a result of reduced hardware cost, reduced leased circuit cost, increased services sharing the same facility, increased utilization from imaginative pricing schemes or changes in the toll settlement agreement. Finally, the analysis of MTS traffic diversion will give the telephone company a means of identifying that traffic that might be profitably handled on a point-to-point private line basis for the customer. A detailed analysis leading to these conclusions follows.

Assumptions

Three basic assumptions had to be made before beginning:

1. *Only originating DDD traffic would be carried on the new satellite toll network.* It was assumed that the Bell System would deliver the incoming traffic the same way it does now and would not abandon the toll investment they now have.

2. *All originating satellite traffic would have direct access to all other exchanges in the United States.* At the time of the study we found that it was not cheaper to dial a combination OCC-telco call than to dial a point-to-point telco toll call. The customer will pay more for the com-

Distance	Routing	Cost/Hour
400 miles	DDD	$20.54
400 miles	OCC	≈ $15.00
100 miles	DDD	$17.54
500 miles	DDD	$20.56
500 miles	Tandem*	≈ $32.54

* 400 miles - OCC plus 100 miles - DDD

TABLE 1 *The cost per hour of traffic based on the distance and type of routing.*

GERALD S. SCHRAGE is Chief of the Systems Engineering Branch, and JOHN N. ROSE is Revenue Requirements Specialist for the U.S. Department of Agriculture Rural Electrification Administration, Washington, D.C.

Item	Light Route	Medium Route	Heavy Route
Antenna Size	5 meter	10 meter	30 meter
Capacity	1-5 trunks	50-500 trunks	1000-10,000 trunks
Type Channel	DAMA	PreAssigned and DAMA	PreAssigned
Earth Station Cost (1)	$70K-$95K	$200K-$300K	$3M-$4M
Land, Bldg., O.P. (2)	$50K	$100K	$1M
Total First Cost	$120K-$145K	$300K-$400K	$4M-$5M
Annual Charge @ 20% (3)	$24K-$29K	$60K-$80K	$0.8M-$1M
Annual Lease Ckt (600-1000mi) (4)	$7.2K-$36K	$7.2K-$2.52M (5)	$7.2K-$36M (5)
Annual Lease Ckt (1000-3000mi) (4)	$12K-$60K	$12K-$4.2M (5)	$12K-$60M (5)
Total Annual Charge Range	$31.2K-$89K	$67.2K-$4.28M	$0.812M-$61M

Notes:
1. Earth Station Costs estimated from Comsat and RCA data.
2. Land and Building Cost estimated at $50,000. Outside Plant costs estimated at $100/circuit.
3. Annual charge assumed similar to central office equipment.
4. Leased circuit charges based on RCA charges.
5. 30% discount over 50 channels.

TABLE 2 *Earth station parameters and costs.*

bination toll call under present tariffs. Therefore, feasibility could not be based on tandem or through toll switching. Direct access was needed to every exchange (see Table 1).

3. *The results would be compared to the present toll settlements received according to the Ozark plan.* Only the settlements for originating DDD toll would be considered since settlements would remain approximately the same for terminating toll.

Earth stations

The cost of an earth station varies with the channel capacity, antenna size, type of amplifier and receiver and the inclusion of DAMA (demand assignment multiple access). The resultant earth stations usually are either used as light route, medium route or heavy route stations. An Independent telephone company entering the satellite communications field would probably start with a medium route station growing into a heavy route station as the traffic warranted and reusing or selling the displaced earth stations elsewhere. Table 2 lists some characteristics and estimated costs for potential earth stations.

The leased circuit costs can be reduced considerably by leasing transponder space from a satellite owner, especially if interruptible transponders can be used. Typically, COMSAT leases transponders for $1 million/year for interruptible service and $2 million/year for non-interruptible service. Transponders also can be leased in quarter, half and full increments. Assuming 1200 satellite half-circuits per transponder (2 half-circuits per trunk) the annual leased costs are shown in Table 3.

The final stage would be to lease or own an entire satellite by a consortium of Independent telephone companies. Using costs quoted by COMSAT to lease the Comstar satellites, the annual cost would be $16 million per year per satellite for 24 transponders of 1200 half-circuits or 14,400 trunks each.

Potential originating toll revenues were developed by calculating yearly minutes of use of each trunk group size.

The interstate rate per minute for each length of haul adjusted for weekend and night usage was multiplied times the yearly minutes of use to arrive at the originating toll revenues per trunk group (see Table 4).

Net originating toll revenues

Table 5 combines the revenues from Table 4 and the costs from Table 2 plus the ENFIA termination costs to find the breakeven trunk group size. An analysis of the actual toll traffic carried by several typical REA borrowers indicated that the traffic in sufficient usage quantities to consider for diversion

Transponder	#Trunks	Interruptible	Noninterruptible
1	600	$1 M	$2 M
½	300	$0.5 M	$1 M
¼	150	$0.25M	$0.5M

TABLE 3 *Annual transponder costs.*

TABLE 4 *Annual originating MSG toll revenues per trunk group $(000).*

	TRUNK LENGTH					
Trunks	10 Miles	25 Miles	50 Miles	100 Miles	500 Miles	2000 Miles
5	15	30	40	45	50	56
10	48	97	129	145	161	182
15	87	174	232	261	291	329
20	129	259	345	388	431	488
25	173	347	462	520	578	655
30	219	437	583	656	729	826
40	312	625	833	937	1041	1180
50	409	817	1090	1226	1362	1543
75	657	1314	1752	1971	2190	2482
100	912	1825	2433	2737	3041	3447

Note: The interstate rate per minute per mileage band, adjusted for discount period usage, was applied to yearly minutes of use per trunk group developed from traffic busy hour tables.

No. of Circuits	Earth Station & Lease Circuit Costs	Local Termination Costs	Total Costs	Revenues(1)	Net Difference	Ozark Settlements	Net Difference(2)
5	96	7	103	45	(58)	19	(77)
10	132	19	151	145	(6)	61	(67)
15	168	35	203	261	58	110	(52)
20	204	51	255	388	133	163	(30)
25	240	68	308	520	212	218	(6)
30	276	85	361	656	295	276	19
40	312 (3)	110	422	937	515	394	121
50	312 (3)	130	442	1226	784	515	269
75	438 (3)	240	678	1971	1293	828	465
100	564 (3)	340	904	2737	1833	1150	683

Notes:
1. The average length of haul for a toll call for REA borrowers is approximately 100 miles. The interstate rate per minute per mileage band, adjusted for discount period usage, was applied to yearly minutes of use per trunk group developed from traffic busy hour tables.
2. The feasibility is compared to the present Bell System delivery of originating toll. Therefore, the current toll settlements must be considered with costs and originating revenues.
3. 30 percent discount on lease circuits.

TABLE 5 *Annual cost satellite feasibility—earth station at each CO $(000).*

was short haul in characteristic and so from Table 4 the 100-mile length trunk circuit was chosen for analysis. As can be seen in Table 5 for the assumptions made, an Independent telephone company *cannot* enter the satellite trunk network business on a light route basis. Only if the Independent telephone company has a toll trunk group of 30 or more trunks for originating traffic could net revenue increase over what is presently received in the Ozark settlement process. The average REA borrower central office has 15 trunks for originating traffic. This is far short of the needed 30 trunks.

Under a reduced SLU (subscriber line usage) settlement plan even larger trunk groups are needed. The assumption is that under a reduced SLU settlement plan there would be less toll revenue requirements and therefore less toll rates and revenues. An analysis of a reduction of SLU by 20% raises the minimum size of the toll trunk group to at least 40 trunks.

Terrestrial microwave

Since having an earth station at each central office did not prove

Cumulative No. of Central Off.	Cumulative Trunks(1)	Earth Station & Lease C. Costs	Other Costs(2)	Total Costs	Revenues(3)	Ozark Settlements	Net Difference(4)
1	15	168	68	236	261	110	-85
2	25	240	154	394	520	218	-92
3	33	298	213	511	738	310	-83
4	41	312	297	609	952	400	-57
5	48	312	378	690	1151	483	-22
6	54	333	451	784	1334	560	-10

Notes:
1. There are 15 trunks in the average REA borrower central office for originating DDD message toll traffic. As this traffic is combined for satellite transmission, efficiencies are realized and the size of combined group is less than the sum of the individual groups.
2. Included in this column are exchange termination costs based on ENFIA methods, 2GHz digital microwave, switching, and other miscellaneous costs.
3. The average length of haul for a toll call for REA borrowers is approximatly 100 miles. The interstate rate per minute per mileage band, adjusted for discount period usage, was applied to yearly minutes of use per trunk group developed from busy hour traffic tables.
4. The feasibility of the combination satellite microwave system is compared to the present Bell system delivery of originating toll. Therefore, the current toll settlements must be considered with costs and originating toll revenues.

TABLE 6 *Combination satellite—microwave annual cost feasibility $(000).*

feasible for REA borrowers, we then investigated the possibility of several REA borrowers who are in close proximity concentrating their individual toll traffic by means of terrestrial digital microwave radio into a single jointly-owned earth station.

Table 6 expands Table 5 by adding the number of central offices and other costs such as digital microwave and switching to the ENFIA type termination costs. The average REA central office has 15 originating toll trunks and the microwave radio was assumed to be a single hop star configuration into the single earth station site. The results show that traffic from more than six central offices must be concentrated to increase net revenue on the present settlement basis. Given a reduced SLU basis of settlement even more central offices need to be concentrated. With a 20% SLU reduction, the minimum number of central offices is at least seven. There is a point of diminishing return since the more central offices combined the greater the distances and the microwave costs to concentrate the toll trunks at one point.

TRUNKS	TRUNK LENGTH 100 MILES	200 MILES	300 MILES
12	-29	-82	-181
24	- 1	-43	- 89
36	33	- 5	- 44
48	63	33	3
60	95	71	48
72	125	109	94
84	156	146	139
96	188	186	185

ANNUAL NET REVENUE POINT TO POINT EXECUNET TYPE SERVICE
$(000)

TRUNKS	TRUNK LENGTH 100 MILES	200 MILES	300 MILES
12	-25	-78	-138
24	11	-35	- 95
36	46	14	- 53
48	82	38	- 10
60	117	63	32
72	152	88	74
84	188	111	117
96	223	137	159

Note: Costs are for 2 GHz digital microwave routes. Rates are similar to the Bell interstate mileage rate between a category (A) rate center and category (B) rate center.

TABLE 7 *The annual new revenue for special service trunks and the annual net revenue for point to point Execunet type service $(000).*

Net revenue for special services

Since we already had developed the microwave costs, we also decided to study the feasibility of microwave routes for special service and Execunet type services. Rates for special services were based on Bell interstate rates. Consideration was given that the rates would have to be cheaper than Bell's to attract customers. This reasoning also was used for developing Execunet type service revenues.

Approximately 36 trunks are needed for a 100-mile borrower-owned microwave route to provide economically feasible special services or point-to-point Execunet type of service. As the routes get longer, even more trunks are needed to prove feasibility. REA borrowers, in general, have far less traffic than is required to support these types of services on a cost basis. This feasibility does not include the reduction in toll revenues (see Table 7) resulting from customers switching from MTS. ☐

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ALAN B. KAMMAN

World telecom market: size and potential

MOST OF THE numbers that one must use to describe the world's telecommunication markets are large. The headlines of telecommunication trade journals are filled with 'millions' and 'billions'; the statistics of common carriers are presented in columns headed by '10^3' and '10^6' multipliers; and so this article will necessarily be punctuated with those same large numbers. For example, Arthur D. Little's World Telecommunications Study II projects that the world will have at least 523 million main telephone stations in operation by 1991, and that growth will foster equipment markets totaling over $367 billion during the 1980-1990 period.

This article projects telecommunication markets over the next decade. It highlights the economic factors behind the markets—operating revenues and capital investments—for each of six regions. Patterns of changes are noted, and examples are cited to illustrate reasons for the various projections.

Market projections by different professional organizations, covering what appear to be similar subjects and periods, are often at variance.

The reason can usually be traced to differing definitions. Therefore, to avoid misinterpretation of our projections, here are a few definitions. The six *regional diversions* we use follow the United Nations (UN) convention: Latin America, North America, Africa, Asia, Europe and Oceania. The USSR is included in Asia. We speak of both *public and private systems*, including government-owned (non-military) facilities in the later category. When a specific year is shown it stands for year-end and all fiscal year data has been adjusted to year-end.

Probably the most loosely-defined term among forecasters is 'market.' What is included? Does the projected amount cover freight and handling costs? Installation labor? Land and building space? To reduce the number of variables we define an equipment market in terms of 'shipments' as priced at the factory, not including such costs as on-site engineering and installation labor. We use US dollars as a monetary unit, with projections given in 1979 dollars and historical financial data given in dollars converted from national currencies at the year-end exchange rate of the year shown.

Current situation

The decade of the '70s has been most significant for the expansion of the world's *telephone* facilities: as we predicted in our 1970-71 report, while North America has historically had the predominant telephone population, by the end of 1980 there will be more telephone main stations connected in the European region than in North America—for the first time ever. Perhaps of even greater significance, by the end of 1980 we predict there will be more main stations installed in Asia than there were in North America in 1970.

The growth in telex service is another basic indication of the pace of 1970-80 telecommunication systems expansion. The number of

Continued on page 120

TABLE 1 *Major manufacturers of telecommunications equipment.*

COMPANY	Total Sales * 1976	Total Sales * 1977	Sales* of Telecommunications Equipment 1976	Sales* of Telecommunications Equipment 1977
Western Electric	6.93	8.14	6.93	8.14
ITT	14.88	16.69	3.35	3.77
Siemens	8.91	10.85	1.96	2.09
LM Ericsson	1.56	1.67	1.56	1.67
GTE	3.06	3.56	1.33	1.54
Northern Telecom	1.08	1.27	1.08	1.27
Nippon Electric	1.92	2.27	0.84	0.90
Philips	12.40	12.70	0.82	0.85
CGE	5.79	6.65	0.63	0.72**
Thomson CSF	3.43	4.01	0.60	0.70**
GEC	3.06	3.59	0.53	0.62**
Plessey	0.86	0.99	0.36	0.45**
	63.88	72.39	20.02	22.72**

*In billions of U.S. dollars.

**Arthur D. Little, Inc., estimates.

Alan B. Kamman is Vice President-Telecommunications Sciences at Arthur D. Little, Inc., Cambridge, Mass. This article has been adapted from a presentation made at the 3rd Telecommunication Forum at Telecom 79, held Sept. 20-26 in Geneva, Switzerland.

Seven-year-old Swiss lad throws the switch in a revolving microwave transmission display. Many family groups visited the exposition.

BR Communications

New Orleans jazz band was a big attraction in EIA/USA pavilion.

Big crowd puller was Comtech Labs' father-and-son walking, talking robots. Here, Gustaf Douglas (r) leads lost baby robot out of the L.M. Ericsson stand.

Grabbing a quick snack at an exposition hall lunch counter are TELEPHONY's Ed Robinson and Beatrice Ernst, of Telequal, Paris.

Transatlantic backgammon tournament conducted by ITT pitted Geneva team against one from New York. Final display shows New York as the winner. Facsimile transmission device is in foreground.

T WORLD COMMUNICATIONS
ERNATIONAL BACKGAMMON TOURNAMENT
VIA HIGH SPEED FACSIMILE
Geneva 2
New York WINNER

Four-way toast with California wine involves (l-r) William Vanden Heuvel, U.S. ambassador to UN missions; Werner Wolter, of ITU; President Robert Bunke of USITA; and U.S. Commerce Secretary Juanita Kreps.

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subscribers grew from 481,000 in 1970, to over 994,000 in 1977, and we estimate there will be over 1.3 million subscribers by the end of the decade. The scale of the European region's telex network continues to exceed all other regions and seems likely to do so for many years to come.

Several factors directly influence the rate of growth of telephone, telex and other facilities—beyond the pent-up demand for initial communication services. Among the driving factors is the financial health of the operating organization and the amount of revenues obtained. In 1975, we estimate that the world's telecommunications operating entities collected $87,794,000,000 in revenues, 45% of which was derived by North American common carriers. Relating markets to operating revenues, in our 1970-71 study we estimated the 1975 equipment market in the 33 countries we surveyed to be approximately $17 billion. Looking at 1980, we project that worldwide telecommunications operating revenues will exceed $171 billion, and equipment markets will reach about 30% of that amount.

Concerning markets in the decade 1970-1980, we estimate that buyers—principally common carriers—spent $188 billion for telecommunications equipment, of which about $52 billion will be spent in 1980.

Who supplies the equipment that is being purchased? Table 1 lists the major manufacturers and shows our estimation of their sales of telecommunications equipment. Western Electric supplies essentially to the U.S. market only, however the remaining manufacturers compete worldwide for market shares.

Market projections

The rapidly changing situation in the worldwide telecommunications market is best illustrated by a projection of public telephone systems, shown in Figure 1. As stated earlier, both Europe and Asia have exhibited strong telephone network growth since 1970, and we forecast continued rapid expansion in the '80s. In the early 1990s, the Asian network will also overtake North America's in size. Among the three regions with smaller scale networks, we project that Latin America and Africa will both have above average growth rates in the 1980s. Note that the Latin America telephone systems of 1990 will nearly match the 1970 Asian network in scale.

The relative distribution of telex subscribers worldwide is also changing, as illustrated in Figure 2. A particularly strong growth has been exhibited in the Asian region, which is projected to continue. By 1990, we predict that telex subscribers in Asia will outnumber those in North America, as the result of increases in the scale of LDC telex networks and the contrasting replacement usage of data and facsimile systems in North America.

Observing the related increases in telecommunications operating

TABLE 2 *Telecommunications operating revenues.*

REGION	1975	1980	1990	% OF 1980 TOTAL	% OF 1990 TOTAL
North America	39.49*	66.90	122.09	39	32
Europe	26.56	56.49	164.27	33	43
Asia	17.20	38.70	80.22	23	21
Latin America	2.26	4.17	9.38	2	2
Oceania	1.65	3.37	4.33	2	1
Africa	0.64	1.58	3.85	1	1
	87.80	171.21	384.14		

*In billion (10^9) U.S. dollars.

TABLE 3 *Regional markets.*

REGION	Period of Shipments 1970-80	1980-90
North America	62.2*	103.4
Europe	76.3	176.7
Asia	39.1	59.7
Latin America	5.7	15.5
Africa	1.6	4.7
Oceania	3.3	6.7
	182.2	366.7

*In billion (10^9) U.S. dollars.

TABLE 4 *Equipment markets.*

EQUIPMENT	Period of Shipments 1970-80	1980-90
Telephone c.o. switching	47.3*	92.5
Long-haul transmission	27.7	53.1
Local distribution	60.4	117.4
Station apparatus	35.5	68.5
Other telecommunications eq.	17.3	35.2
	188.2	366.7

*In billion (10^9) U.S. dollars.

'Several factors directly influence the rate of growth of telephone, telex and other facilities—beyond the pent-up demand for initial communications services.'

revenues, Table 2 shows the huge sums that are expected to accrue to telecom common carriers in specific years.

The changing regional relationships, which will be particularly evident in the 1980s, may be seen.

Equipment markets

With public telephone systems growth setting the pace, we project that the telecommunication equipment markets of the 1980s will nearly double the amounts shipped in the 1970s—from just under $190 billion to over $381 billion. In Table 3, we translate those estimates into regional shares, and show that the 1980-90 European market alone will nearly equal that of North America, Asia and Latin America combined.

To complete the equipment market picture, Table 4 shows total sales for the two decades, but subdivided by equipment category. Despite differences in the relative expenditures from category to category between countries—related to a country's size, and the technology being purchased—the percent of total market represented by switching, local distribution and station apparatus are likely to remain fairly constant for at least the next decade. Note that we expect transmission to take a slightly smaller share of the total market, and other telecommunications equipment (such as mobile radio systems) to increase in share.

Observations

In the most general classifications of markets one can place a country in one of four stages of telecommunications development. At the most fundamental level, telegraph is still important and telegraph traffic continues to increase. Telecommunications markets are small and the technology employed is quite mature.

At the next level, the emphasis is on telex systems and urban telephone service. Market emphasis shifts accordingly toward switching equipment.

At the third level, typified by most industrial countries in the world, automated nationwide telephone service is most important. In such markets the emphasis is increasingly on digital switching and transmission equipment. Regional and international coordination of equipment standards becomes vital to this third level market.

We see the next level—the most advanced market—to be where voice/data service combinations, "office of the future" services, and integrated fixed and mobile systems are coming into use. The services are provided over facilities that have been converted to digital equipment. The United States and a few other countries are presently evolving to this level. Most countries will be concerned with level four after 1990.

The world's telecommunications equipment markets will reach well over $40 billion annually by 1990, and will still be increasing at a steady pace. With approximately 523 million telephone main stations installed to serve a world population, that is expected to be 5302 million, we are still far short of a saturated market. □

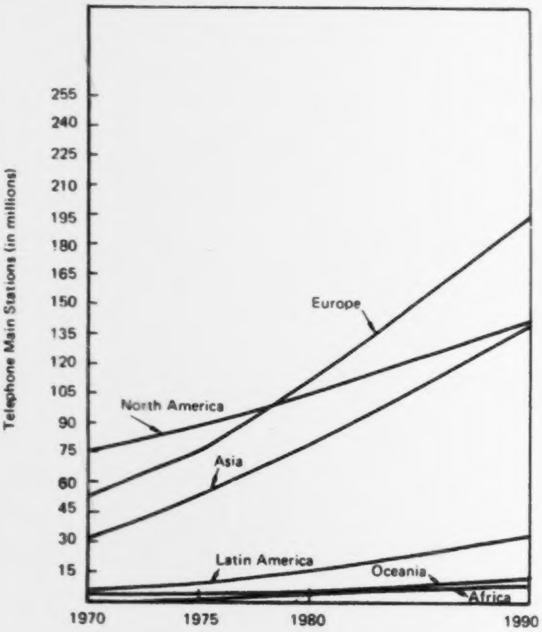
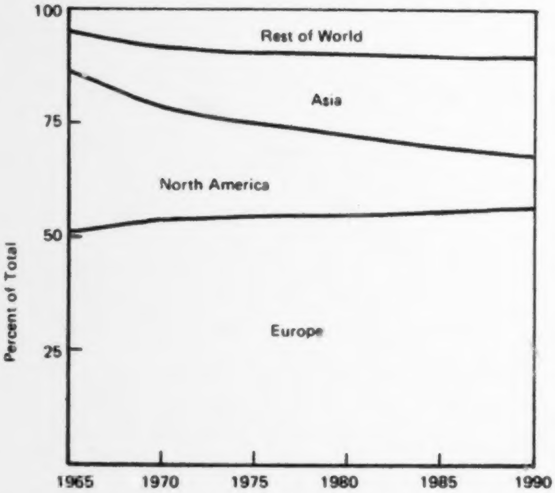


FIG. 1 *Projection of public telephone systems.*

FIG. 2 *Projection of public telex subscribers.*



Source: Telex inder Welt data; Arthur D. Little, Inc., estimates.

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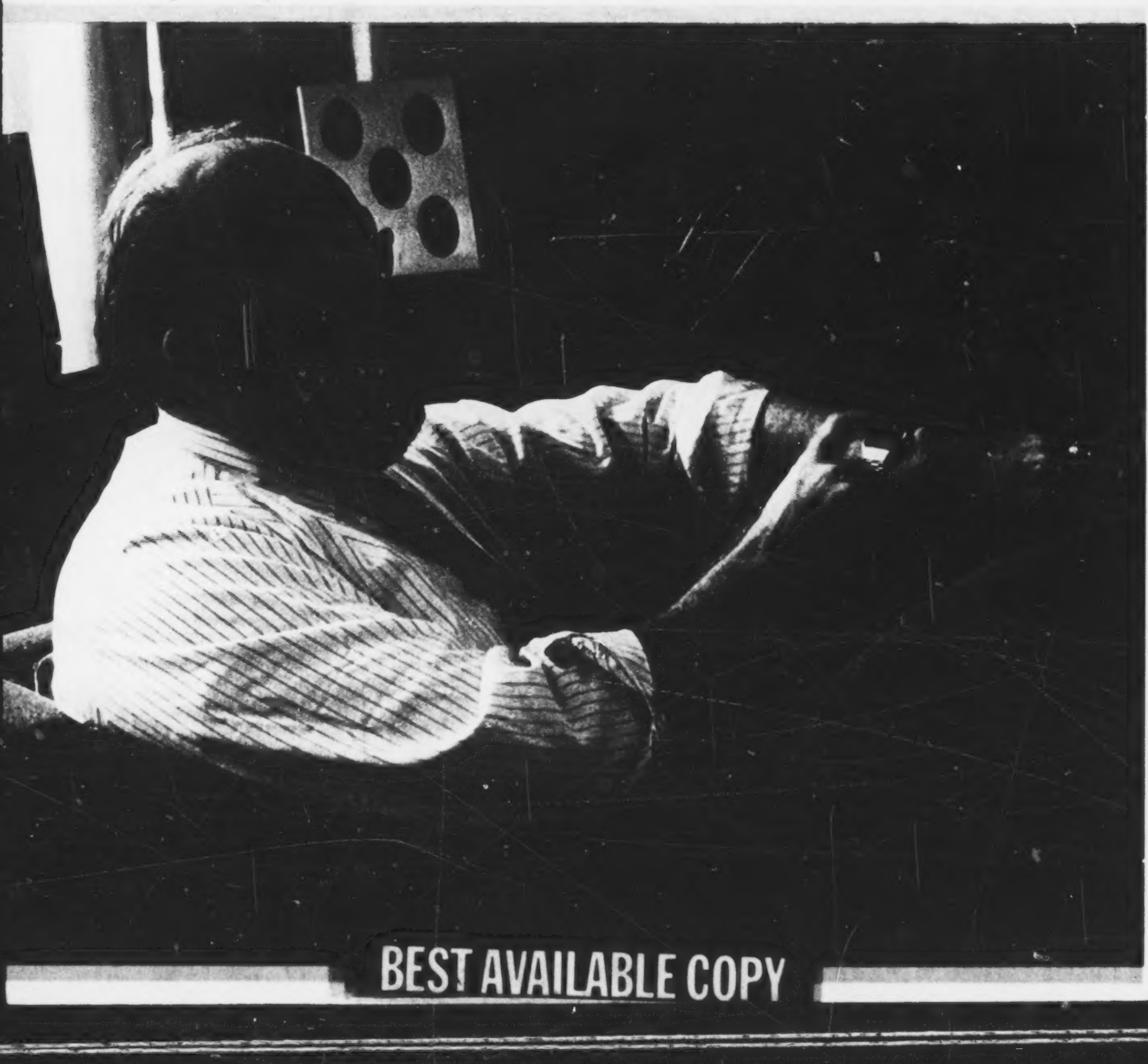

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The century of the satellite

Will 'leverage of specialization' replace 'economy of scale' as the linchpin of future telecom networks? Yes, says the author, and satellites will lead the way

Dr. Albert D. Wheelon

WE ARE living in a decade of extraordinary change driven by rapid advancements in the technology of computers and communications. This decade will set the direction and pace for the next century and will have a fundamental effect on every nation.

In the United States today, major telecommunications changes are occurring constantly. Computers and information are coming together in a way that demands new communication capabilities. Demand for new and more powerful communication service is accelerating. Vigorous new entrants are on the American communication scene. Evolving public attitudes toward television and telecommunications are beginning to influence national policy in important new ways. Competition is being tried on an increasingly wide scale, and is questioning the presumptive role of telecommunications monopolies.

The classic assumption of *economy of scale* is being challenged by the *leverage of specialization*. Leasing of communications facilities is developing as an important alternative to purchase. Sharing of facilities is increasing in place of exclusive ownership. Innovative financing of large telecommunications systems if beginning. Technology is creating opportunities for new services faster than public policy can be established to guide them comfortably. Let us look more carefully at these developments.

The Bell System provides the United States with an integrated telecommunications system of unusual capacity and quality. Ten years ago competition with this nationwide system of long lines facilities and local loops was not seriously considered. Yet today it is happening.

The first to compete were specialized microwave carriers which attempted to duplicate the terrestrial links of the Bell System on a selective basis. They soon found the capital requirements too large and the rewards too small. The next step was a new public policy requiring Bell to make its facilities available to competitive services. Opening the network to other users has produced a considerable amount of service innovation and has stimulated Bell itself in interesting ways. Its Advanced Communications Service is an example of Bell's response to the challenge of others.

The real agent of competition proved to be the communication satellite. With a satellite investment of $100 million or $200 million, a company could duplicate the long lines capacity of the terrestrial network. And this capacity could be operational in two or three years. With such a system, a competitor could provide service to as many points as desired with low cost earth stations. Public policy in the U.S. allowed, even tacitly encouraged, private companies to establish satellite systems at their own risk. Statistics on these systems are listed in Figure 1.

These systems have emerged since the U.S. government proclaimed its Open Skies Policy for domestic satellite communications in 1972. Their effect is pronounced. A rich fare of television programing is becoming available through a combination of satellites and cable TV systems. Communication services are being tailored to user's needs. The prospect of inexpensive, wideband data communications service is allowing the computer and office copier industry to take the next major steps in those technologies. Large companies are entering the communication equipment market in forceful and diversifed ways. The time scale for introducing new services is shortening dramatically under the press of competition.

There is another side to this competition. It is generally understood that a substantial amount of rate-averaging or cross-subsidy occurs in a monopoly network. Profitable long distance and business services generally support the not-so-profitable rural telecommunication systems. This is done as a matter of public policy. When a specialized carrier caters to the data needs of large industrial users, as SBS and Xerox propose to do, it may undercut the financial basis for public message service. On the other hand, if the specialized carrier provides new services that were not available for purchase from the monopoly network, they will not detract from the public

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DR. ALBERT D. WHEELON is Group Executive, Space & Communications Group and Vice President for Hughes Aircraft Co., Los Angeles, Cal. This article is adapted from his presentation at the 3rd World Telecommunication Forum, Geneva, Switzerland, on Sept. 20.

message service. Both viewpoints have been argued, sometimes in disguised form.

This issue has a counterpart in satellite communications. INTELSAT now provides major path and primary service with the same spacecraft at the same rates. It is widely recognized that INTELSAT could provide the high density major path service between Europe and the United States with special purpose spot-beam satellites. It probably could do so at rates below the present structure and probably well below those charged for undersea cables. But that would imply costs of a different kind—opportunity costs for cable layers and possibly rate increases for the smaller users of INTELSAT. On the other hand, to ignore the opportunity for such specialization is to place a different—and possibly greater—burden on the system.

Another kind of satellite specialization is being considered by INTELSAT. It is based on the dissmilar geographical features and traffic demands of the three ocean basins. Thus far, identical satellites have been used in the three locations because the characteristics of all three satellites have been defined by the requirements of the Atlantic basin. Serious consideration now is being given to individualized and more appropriate satellites for each ocean basin. This new approach provides an interesting example of the leverage of specialization, in contrast to the economy of scale.

Satellite technology clearly provides the basis for communication specialization. However, it also supports the traditional economy of scale procedures for very important applications. For example, a spacecraft designed to provide standard coverage becomes progressively more efficient as more transponders are included. The new Hughes SYNCOM IV widebody spacecraft can accommodate as many as 48 transponders. It can do so at a much lower cost per transponder than the older 12 and 24 transponder satellites. Using appropriate financing arrangements, a satellite leasing company could allot three, six or twelve transponders to a small country, permitting it to realize the same low cost per transponder as a country that used all 48 transponders. By specializing its use of those transponders, the leasing nation could custom-tailor a satellite communications system fully responsive to its own requirements.

It is more economical to provide an additional unit of service with a network that already furnishes *similar service*, than it is to establish a new network. This practice forms the basis of incremental pricing. However, a *new kind of service* can be set up more cheaply as an independent module rather than as an increment to an existing network using common facilities. Recent experiments in the United States support this conclusion. The *leverage of specialization* is competing favorably with the *economy of scale* in the satellite era. It is a simple matter to specialize communication satellites, both in configuration and in service. Each satellite can be deployed in space as a module. Because of these technical advances, our economic theorems are changing. Those who cling to the *economy of scale* with common facilities may find themselves in increasingly awkward positions as the influence of satellites spreads. Whatever one's persuasion on the question of monopoly versus competition, no one can afford to ignore the leverage of specialization.

If one accepts the proposition that communication satellites are a major element in the emerging telecommunication model, it is important to understand where their technology and economics are leading. It is difficult to get one's bearings here because space technology has been glamorized by manned spaceflight and scientific expeditions to other planets. These ventures have colored the space industry with considerable romance. They also have invoked a high level of national prestige-consciousness.

We must look at satellites in a different light. We must realize that satellite systems can either frustrate or facilitate the provision of new services. They can provide more—or less—economical solutions to communication problems. They influence the price of communications both through their own costs and through the burden they place on ground stations.

Let us examine the costs of establishing satellite communication services in more detail. The direct cost of a satellite is composed of 1) the spacecraft itself, 2) its launch into geosynchronous orbit, and 3) insurance of the launch. The three elements invite careful attention. Spacecraft for telecommunications today cost $20 million to $30 million. They generally are procured on a firm fixed-price contractual basis. A substantial portion of the total price is paid only if the spacecraft perform satisfactorily in space for seven years or more. Financial penalties usually are incurred for late delivery. About half of the world's communication satellites have been procured by open competition and about half by negotiation. Most of the negotiated contracts were for standard spacecraft or modifications thereof. However, some operating companies have been unwilling to commit their communication traffic and revenue to a satellite chosen by the lowest bid price, and have retained their right to choose the best mixture of price and quality to meet their operational needs. For the most part, open competitions and price auctions prevail, and they have driven spacecraft prices to very attractive levels. This price reduction does not allow much international sharing of spacecraft development. There is considerable pressure to distribute satellite construction responsibilities; however, the relentless pressure of price competition has eliminated this practice except for a few international programs that are willing

FIG. 1 *U.S. domestic communications satellite systems.*

OPERATORS	START DATE	NO. OF SATELLITES	NO. OF CHANNELS	FREQUENCY GHz	BUILDER
ATT/GTE	1976	3	24	6/4	Hughes
Western Union	1974	3	12	6/4	Hughes
RCA	1976	2	24	6/4	RCA
SBS	1981	(3)	10	14/11	Hughes

NOTE: Xerox Corporation recently announced its intention to establish a nationwide satellite network.

and able to pay a surcharge for group comity.

The second important element of satellite system cost is the launch vehicle. All commercial communication satellites to date have been placed on orbit by either of two expendable U.S. rockets—the Delta and the Atlas Centaur. In 1970 the unit prices for these rockets were $5 million and $14 million, respectively. The prices will increase to $26 million for a Delta 3910-PAM and $40 million for an Atlas Centaur for launches in 1980. The rise reflects inflation and the approaching phase-out of these vehicles.

Three new launch systems are about to become operational: the U.S. Space Transportation System or Shuttle; the Japanese N-rocket and the European Ariane. The N-rocket is similar to the U.S. Thor Delta and is built under license in Japan. It has already flown from Tanegashima Island in Southern Japan, and takes a 300 lb. payload into synchronous orbit for a reported cost of $75 million. The Ariane is similar to the Atlas Centaur and can place about 2200 lbs. in geostationary orbit from a near-equatorial launch site in French Guiana. The first Ariane will be launched early in 1980 at a launch price of $15 million. Space Shuttle also will make its initial flight early in 1980. It will be launched from Florida and will place 65,000 lbs. into a low altitude earth orbit. To raise a communication satellite to geosychronous orbit, one of four payload assist modules must be used: (1) the PAM-D with an orbital payload of roughly 1240 lbs., (2) the PAM-A with a payload of 2290 lbs., (3) the Inertial Upper Stage (IUS) with a payload of 5000 lbs., or (4) integral propulsion system of SYNCOM 4 which allows a payload of about 3000 lbs. to be placed in orbit.

The cost of launching a 1240 lb. payload with the Shuttle and PAM-D in 1982 will be roughly $11 million. The cost of launching a larger satellite with integral propulsion, such as the 3000 lb. LEASAT, will be about $13 million in 1982.

The important point is that launch costs soon will drop significantly. This decrease is due primarily to the reusable feature of the Shuttle and the opportunity for ride-sharing offered by its large capacity. Ariane launches will be priced competitively with Shuttle launches to attract a share of the business.

Launch insurance is the third important element of satellite system cost. The threat of a launch loss is a financial burden that many system operators are unwilling to bear. To minimize this financial exposure, the London insurance market has offered launch insurance for over 10 years. The forms of available coverage have kept pace with the changes in technology. For the early INTELSAT launches, it was possible to obtain insurance only on the basis of large deductible losses. Moreover, the available insurance capacity for the early policies was less than $10 million, so only limited indemnifications could be provided. By comparison, full coverage of launch vehicle and satellite costs readily is available today with insurance capacity in excess of $50 million per launch. The current rate for expendable launch vehicles is less than 10% of the value insured, reflecting the 90% reliability of existing rockets. The corresponding rate for the Shuttle is expected to be significantly lower because of the improved reliability (98%) demanded by a vehicle transporting astronauts. The underwriters have yet to establish insurance rates for Ariane and the N-rocket.

A more recent development in the space insurance market is the variety of insurance for satellites' operational life. Owners of satellite systems now can protect themselves against partial failures or a total loss of communication capacity in orbit. The evolution of launch insurance and in-orbit life insurance has greatly reduced the financial risks of satellite ownership. These developments have all but removed the threat of major financial loss. They permit potential owners of satellite systems to concentrate implementation decisions on known cost factors and social benefits, rather than launch and operating risks.

Satellites' impact

The communication satellite exerts another major influence on the economics of telecommunications because its performance has direct impact on the ground segment. If the satellite is small and radiates a weak signal, the ground stations must be large and expensive. In a system with many ground stations, the total system cost can be increased disproportionately by economizing on the spacecraft. The opposite problem occurs if a very large, multipurpose satellite with high launch costs is chosen to operate with small, inexpensive earth stations. The apparent economy of scale associated with sharing the housekeeping functions on a large spacecraft easily can be overridden by the cost of completely replacing a complex satellite when only a few of its transponders have failed.

The system architect has the important responsibility of balancing the functions of the ground and space segments to reduce total system costs. A number of qualified consulting concerns offer system architectural service to potential system owners. Such counsel also can help a nation avoid uneconomic solutions to its telecommunication problems. The user can expect to feel considerable pressure from alliances of industries and nations committed to particular launch systems or satellite designs. The systems may or may not provide economic communications.

This point can be illustrated by comparing the Boeing 747 and Concorde airplanes. The first was developed with private funds in response to airline needs. The other was magnificent technology developed with government funding as a matter of national policy. As a technologist and frequent airline passenger, I am delighted that we have both aircraft. Air France and British Airways, who have operated the two aircraft, report profits on one and losses on the other.

The communication satellite field has had its economic disappointments. The AEROSAT program was largely conceived in an industrial and political context. It began as an expensive experiment in international space technology. The intended beneficiary, the airline community, took a dim view of the project. It expressed its opposition forcefully, and the program ended. Intrinsic economic viability is a requirement for communication satellites, just as it is for transport aircraft.

Satellite design should be driven by telecommunication needs, not the other way around. In the growing environment of service competition, the communication user who chooses a noneconomic solution runs a considerable risk. High purchase, operating and replacement costs leave a communication system open to criticism, vulnerable to challenge, and in danger of displacement. Truly economic solutions are widely available using the most modern technology. They should be chosen competitively in preference to political solutions. The time necessary to explore the economic effects of alternate solutions well spent for the prospective system user.

Another important consideration for the prospective satellite user is system growth. Satellites have a finite lifetime. Batteries and tubes wear out in about seven years, just as the station-keeping propellant eventually is exhausted. A replacement satellite, probably ordered three years before, must be ready to launch at that point. Usually the traffic will have grown significantly in seven years and additional services will be required. This means that the new satellite will need more capability than its predecessor. Experience has shown that the technical and contractual definition of a second generation satellite usually is more difficult than that of its predessor. The satellite must meet a more complicated mixture of communication needs. It can be chosen from a richer array of space technology options. Like an airline, a communication entity must look to the future in choosing a satellite system supplier to ensure that the company will be vigorous and available for the next step in system growth.

The financial outlook

New financing forces are appearing on the telecommunication scene. Large sources of private capital in New York and Europe have become interested in satellite communications. For many years, these capital sources have financed transportation and other development projects. In the last two years, the world's large venture and investment capital managers have become comfortable with space technology. They now are convinced that telecommunication services via satellite present attractive investment opportunities.

One of the most interesting developments in the financing of satellite communications is the introduction of leasing. The application is similar to the aircraft industry and airlines. The titles to about half the world's commercial aircraft are held by groups of banks and investors. The airplanes are leased to the operating airlines. Satellite leasing works the same way. The difference is that the spacecraft is 22,000 miles above the earth. The legal question of title to the hardware that operates at such a great distance is a new but unimportant issue. Legal title has no effect on the telecommunication operator who provides service, or the investor/owners who provide the financing.

A more significant issue is the access to the nominal orbital position and frequency allocation coordinated through the international Telecommunications Union and used by the operating nation or International operator concerned. The general policy framework for using such resources is under discussion by the World Administrative Radio Conference in Geneva, Switzerland.

Leasing has the significant advantage for the operator of not requiring a large capital investment prior to start of service. That investment now can be made by the financial community. The operator pays for the service as it becomes available, and usually can cover this expense with operating revenues. The latter point may be an important advantage for developing nations.

Leasing has other advantages. While most contractors for purchasing satellites assign a fraction of the selling price to in-orbit performance, the majority of the financial risk is borne by the purchaser/operator. In the leasing arrangement, all the risk is borne by the seller/owner. The operator pays nothing until the satellite is operating in orbit according to contractual specification.

Leasing has a further advantage for the operator: it equalizes the outlay of investment capital. Satellite purchase requires a large amount of capital every five to ten years for replacement costs, with only small operating expenses in the meantime. The operator who leases service can budget a steady, predictable amount each year and thus avoid large capital appropriate swings. This plan has proved attractive to government agencies in the United States. It accounts for the satellite leasing programs of the U.S. Navy with Hughes and COMSAT and of NASA (National Aeronautic & Space Administration) with Western Union. It is likely that telecom administrations that depend on parliamentary appropriations will find leasing an interesting alternative to purchase/ownership.

A link exists between leasing and technology. Because the lessors bear the full risk of in-orbit performance, they usually insist on the most reliable technology. When COMSAT leased the Comstar satellite systems to Bell, it reserved the right to choose its own satellite supplier (Hughes) without competition, and to influence the spacecraft design significantly.

Leasing is proving popular for providing domestic satellite communication service also. INTELSAT is leasing transponders to its member nations at increasingly attractive rates. They provide this capacity with channels not immediately needed for international service. Individual members like Brazil and Nigeria use this leased capacity to establish domestic communications within their countries. Sixteen countries now lease transponders under this program, providing revenue to INTELSAT of $16 million per year. INTELSAT is considering the provision of backup capacity for these domestic channels, so that lessees can be sure their service will not be interrupted by other demands on the INTELSAT system. This program has substantial advantages and a small problem. Because INTELSAT is a respected international organization, it is in a favorable position to provide such service in an even-handed way. It can furnish the service on an incremental basis and thereby provide the economy of scale to its members-users. It clearly has the financial resources and operational experience to do so. Its present limitation is that it provides domestic service through satellites designed for global service and and located over the ocean centers. As a result, INTELSAT delivers a substantially weaker signal (22 dBw) than the domestic satellites currently operated by Canada, the United States, and Indonesia (33 dBW). This power difference is significant and causes the earth stations to be approximately three times larger than those used with the domestic systems. INTELSAT therefore is considering the purchase of suitably modified international spacecraft or special satellites which can provide the higher signal level.

Share and share alike

This discussion leads us to consider another innovation in the era of satellite communications: facility sharing. Undersea cable capacity has been shared for many years, both in its ownership and its use. The Indefeasible Right of Use concept was developed by American Telephone & Telegraph Corp. to allow the U.S. international record carriers to participate in the benefits of partial cable ownership. Two of the three major satellite leasing programs in the United States are based on facilities sharing—carrying two different kinds of communication transponders on the same spacecraft. Sharing of satellite facilities by two or more countries is technically feasible and economically attractive. Indonesia has shared the use of the Palapa satellite with its neighbors in Southeast Asia on a lease basis. Interests of national prestige and priority of use in the event of satellite malfunction require careful consideration; however, sharing space facilities makes such good economic sense that it is sure to expand rapidly.

If leasing or sharing communication satellite facilities is not attractive, what about outright ownership? Prospects are excellent. Private loans from established sources are available in the United States, Europe and Canada. The U.S. Export-Import Bank (EXIM) has been active in arranging loans for satellite systems in foreign countries. It provided 45% of the financing for Indonesia's satellite system and guaranteed the 55% supplied by commercial banks. Export-Import loans usually carry a requirement that the funds be spent for U.S. equipment, as do other development banks. It also insists a positive evaluation of economic feasibility be provided in advance and that a consultant monitor the evolution of the system.

The counterparts of EXIM in other countries provide similar financing with attractive interest rates and "grace" periods for repayment. The World Bank has not yet expressed interest in these programs, but may change its priorities. For countries with heavy financial commitments or general credit problems, the U.S. Agency for International Development (AID) has already stated its willingness to support satellite projects that provide rural telephone service in developing nations.

Today the user of communications, rather than the supplier, is in the driver's seat. A complexity of choices is available today to the user, but he must choose wisely from this array. A nation new to telecommunications need not repeat all the steps in the development of telecommunications that have been taken in the past. A nation now can enter the process at the latest stage of evolution, and install a powerful, new satellite system suited to its own social and economic needs—and matched to its resources.

There are overriding advantages of communication satellite systems. Their cost in relation to capability is very small and affordable compared with the substantial cost of installing microwave plants throughout a country.

- They can be installed in two to three years.
- There is a variety of attractive ways to finance their purchase or lease.
- Reliable satellites are available competitively from several qualified suppliers around the world.
- They lend themselves both to *economy of scale* and to *leverage of specialization*, depending on design and system use.
- They can be procured on a fixed price basis.
- They provide communications solutions that can stand the test of long term economic viability.

In the next century we shall see a proliferation of specially tailored domestic and regional systems.

The next 100 years will be a century of competition. It will be a century of specialization. It will be the century of the satellite. And it will be a century of a most extraordinary expansion of telecommunications services. □

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ABDUL RAHMAN K. AL GHUNAIM

The key to international economic development is the development of modern, efficient telecommunications systems in developing countries, the author argues

Telecommunications—the view from Kuwait

TODAY WE are in an age of information. The growth and exchange of information taking place in the course of a year nowadays, perhaps, exceeds all the exchanges that took place since the dawn of civilization. An intelligent world suddenly finds itself articulate. The resulting floodwaters of knowledge have to be guided carefully into productive channels, if people are to be protected from their otherwise destructive potential. At the same time, areas that are insulated from the flow of information can dry up and turn into inhospitable desert, if they are not also brought under the streams of scientific thought and technological progress.

Contagious

In the spread of technological benefits, several international organizations have done commendable work. Chief among them is ITU (International Telecommunication Union).

The ITU is noted for distinguished service in the field of telecommunications for over 100 years.

In the recent past, ITU has generated a commendable amount of activity in the field of technology transfer. In addition to organization global and regional plans for telecommunications development, ITU has arranged tutorial handbooks and publications specially designed to aid the developing countries. The regional plan for the Middle East and Mediterranean development is a thorough treatment of a subject requiring wide-ranging coordination. Similar plans for other developing areas of the world and provision of experts and advisers for implementation are the other important contribution of ITU for telecommunications development. On the subject of rural telecommunications, ITU organized a series of seminars successively in 1972, 1974 and most recently in Sept. 1978. The resulting collection of ideas has contributed greatly to advance the cause of worldwide telecommunications development.

The world is becoming increasingly aware of its responsibility to the developing countries. In 1975, the United Nations General Assembly resolved to promote the activity of international cooperation for the betterment of less developed countries and called upon international agencies to assist in this process.

The United Nations (UN) Economic and Social Council also adopted similar resolutions and the International Bank of Reconstruction and Development rendered the required assistance. The problems of technology transfer for the benefit of the developing countries also were discussed in a series of seminars conducted by the UN Conference on Science and Technology for Development.

This would not be a new process or a new direction because the tradition of international cooperation and assistance, especially for the developing countries of the world, has been well established.

Kuwait's experiences

Here are some of the experiences which we had in developing telecommunications in Kuwait. For those in charge of a vast telecommunications organization, extend-

Abdul Rahaman K. Al Ghunaim is the Undersecretary of the Ministry of Communications, Kuwait. He also is a member of the Board of Governors in INTELSAT and the Vice Chairman of the Assembly of Parties. This article has been adapted from a presentation made at the 3rd World Telecommunication Forum at Telecom 79 held Sept. 20-26 in Geneva Switzerland

ing its jurisdiction over a large territory, the problems of a small state with almost unlimited resources, may not appear to be representative. But our experiences are unique in the sense that in about 20 years we will attempt to embrace the developments of a century. We have indeed come a long way from the early days of 1960 when we had a few thousand telephones, to the present time, when we have almost every sophistication known to the telecommunication industry. Before this era of development, Kuwait had few resources and the people were engaged in trade and fishing. Today, the society is transformed. Apart from oil, industrial output and trade in machinery form a significant part of Kuwait's revenues. The banking and other financial institutions also are well developed. The significant change that has taken place in Kuwait's economy can be seen in Table 1.

Originally confined to the walled city adjoining the Shuwaikh Port, the built up area of Kuwait has extended progressively. In the plans ahead, two new townships are contemplated, one in the Northern zone and one in the South. In the intervening areas, new townships are springing up almost every year.

The telecommunication services have been sufficiently well developed to cope with the demands arising from such unprecedented development. Table 2 illustrates the correlation between (non-oil) trade and telecommunications services.

The variations in telecom traffic precede the corresponding changes in trade figures. The deviations from the expected increases in telephone calls in 1976 and 1978 show the extent to which the services are sensitive to the absence of, or provision of, adequate facilities to carry the traffic. It also is interesting to note that telephone and telex traffic complement each other in times of abnormal difficulty in either of them.

A fundamental need

Looking back over the conditions in Kuwait 20 years ago, one finds an answer for many of the questions raised in international forums concerning telecommunication development. Over all these years, it has been assumed that the developing countries, especially their rural areas, have nothing to communicate. But experience has proved this wrong. To the Kuwaiti tradesmen, 20 years ago, the advantages of telecommunication contact with the outside world were clearly understood.

Today in Kuwait, telecommunication facilities are sought eagerly by every segment of the society. Kuwaities of all ranks, as well as expatriates, demand telephone connections. In areas developed for settling the nomadic Bedouins, a telephone connection is as much in demand as in the center of the city.

The demand for mobile telephones in cars has picked up inspite of a comparatively high price and although, in the small state, fixed telephone terminals are available everywhere with no call charges.

If proof is needed for the hidden demand for telecommunications in any society, the example of Kuwait should be adequate.

As one who has witnessed the transformation of a miniature society from rural to urban, from the uneducated to educated, from the nomadic to a highly motivated metropolitan society with all modem facilities and as one who has witnessed the consequent changes brought about in the life and mores of the people, I can say that this transformation through improved telecommunications is not impossible to achieve all over the world; nor does it cost so much that the world community, as a whole, cannot afford it in the course of a few years.

It should, therefore, be understood that telecommunication development is a fundamental need and has to be given higher priority by governments over the development of the other elements of infrastructure, like roads, and over the other social services like health, hygiene and education.

The only controlling element in the scope for telecommunication development is economic. How much can a society afford and how much does the facility cost? But more important is the spur to economic growth provided by telecommunications. The reason why telecommunication development has been confined to the centers of affluence in the world, and therefore to the cities, is that it has been considered a service which has to pay for itself. Initially, therefore, it was in the hands of private companies with a profit motive. Even when it was passed on to the governments, the concept that it should be self supporting has continued to exist up to this day. No wonder, therefore, that the telephone density has become synonymous with GNP (gross national product), and vast areas of the globe remain isolated and neglected with not even one telephone for miles.

And yet people must communi-

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Year	Manufacturing Industries	Wholesale and Retail Trade	Transport and Communication	Finance, Insurance & Real Estate	Total
71/72	42.0	90.0	41.0	21.0	194.0
75/76	163.7	189.6	84.7	151.1	589.1

TABLE 1 *Gross national product by industrial origin (millions KD).*

cate. Today it is well understood that, like water and food supply, telecommunication facilities stand high on the list of priorities for any society, rural or urban.

It has been said of another important Middle Eastern country that it could easily have become the commercial headquarters of the Middle East, if only the telecommunication facilities there were up-to-date and modern. No trade or banking operations, no operations on shares and stocks and no improvements in educational and health facilities are possible in a country with poor telecommunications. The people have to be in touch with each other constantly and with the utmost efficiency possible.

Erosion though migration

The world's population is expanding at an explosive rate and the mass migration from the rural to the urban areas are creating unimaginable problems for the social planners. The living space in the urban areas gets congested, creating cesspools of polluted air, while the rural societies lose all their charms by this erosion. If this undesirable trend is to be halted and reversed, better telecommunications in rural areas is essential. It also is the cheapest of the several alternatives available.

The telecommunication facilities have advanced so greatly and have such immense possibility that, if they are well planned and installed, it is immaterial whether a person lives in the center of a city or a few hundred miles away. Teledata, video text, fascimile services, electronic mail, teleconferencing facilities as well as developments in the handling of television services for education and health purposes, can and will make one's own location on this planet immaterial. Anyone can be in touch with any type of society anywhere in the world, through modem telecommunications. This way the vast countryside can be opened up for human beings to live and the world can gain much additional living space.

The rural areas

The case for urgent development of rural telecommunications is well recognized. Any responsible society must ensure a uniform spread of facilities. The principle of parity between rural and urban sectors indicates that at least a minimum level of service should be provided for the rural communities. For the development of the rural society, education and health are important.

For these to be provided rapidly, telecommunication facilities must have first priority. Apart from the link with the outside world the telephone provides to the teacher or the medical assistant, it also helps them professionally to derive the maximum benefit from a central educational institution or from a nearby hospital. The telephone or telegraph breaks the sense of isolation for a population and gives the security that only a developed society can provide. Administrators can have greater control over the area. Law and order can be effectively maintained. Warning of impending natural disasters like floods can be conveyed at short notice.

The village can more easily arrange social and cultural functions through telecommunications and thus make life richer for its inhabitants. Timely information on specific activities in marketing, agricultural or veterinary operations can be had.

Thus, telecommunications is necessary not only for the industrial and business efficiency of the developed urban sectors, but also in the interests of social stability and developments in the comparatively weaker sections of the rural sector.

With the addition of facsimile equipment to the voice circuit, handling of record messages becomes routine and can be left to unskilled hands. The facsimile also can aid in quick transmission of records, finger prints and other pictorial information. These will be particularly useful in health and educational programs, as well as in issue of notices to the public. Rural banking can be developed by remote banking facilities. Business can develop through dial-ordering. Crop and general insurance can be effectively handled through effective data processing.

Given the combined will of the people and a few standardized facilities, the opportunities are unlimited.

Apart from the individual telephone terminals providing single party circuits with secrecy of communication, the terminal facilities to be provided should, therefore, include facsimile equipment capable of transmission as well as reception. The voice circuit also can be used for alarms, remote monitoring and data transmissions of various types with appropriate terminal equipment.

Optionally, depending on feasibility, a community center television terminal also can be arranged, provided a TV bearer channel can be extended to the nearest earth station or microwave terminal.

Strategy for development

Experience has shown the type of telecommunication equipment and organization that are best suited to the developing countries. The earlier concept that, because there is a large work force and a need for economy, the discarded technology of the developed countries could be exported to the developing ones, has been proved wrong. The technology best suited to a developed country assumes a well knit organization with a fairly uniform capability in different cadres. The developing country should do with a few capable people while a large number will be entrusted with routine simple activities.

The technology for development should provide for integrated development of all the communication needs of the society. In addition to telephone and telegraph facilities, television and broadcasting should be developed simultaneously. In choosing the terminal equipment, the end product of improved educational and medical assistance should be kept in mind.

The operations expected in the remote or rural areas should be simple and unsophisticated, while the central office in the nearby urban center can have the more complex equipment. The urban centers should be interlinked for overall organizational control and should each be the center of control for all the neighboring areas.

Stability and reliability are important in rural communications, and because the network is so vast and connections so numerous, it is necessary to minimize the chance of systems malfunctioning. Instead of spending money on repair work, it is far better to invest in more reliable equipment initially. One corollary to this maxim would be that, wherever feasible, underground cables should be the main connecting links, rather than overhead wires.

The type of equipment that will be used should be suitable for areas exposed to extreme temperatures, dust and humidity. The construction should be robust and the design should be held fairly stable over a number of years in order to avoid frequent changes of equipment.

The system should have adequate self diagnostic and indication facilities for easy restoration in cases of faults.

The technique adopted should be capable of mass production and easy, rapid installation, if our goal of universal telecommunications is to be achieved in a short time.

And because the organizational base in developing countries cannot be expected to be strong, the telecommunication development and maintenance must be entrusted to regional boards, consisting of all the countries in a region.

A modem approach

These requirements point to a novel and modern approach very different from what has so far been adopted in the developing countries, where open wire lines with a manual or central battery terminal telephone has been the standard rural telecommunication facility. Morse telegraph equipment should be replaced by modern facsimile equipment, and digital techniques should be adopted to provide a number of telephone connections on a single pair of wires in a cable.

The key to rural communication development will be satellite communication, with small sized antennas. Whereas extensive installations of terrestrial systems are likely to be costly and time consuming, installation of earth stations at rural centers could be economical in both time and money. From each such rural center, communication can be extended to the neighboring villages by one or more of a few standardized arrangements, using radio equipment or coaxial or paired cables. Large scale integrated circuits on printed boards will be used resulting in reduced size of equipment and ease of maintenance. With the constraints as stated above, it is perhaps inevitable that the terminal device will be very different from the currently available equipment. They may use digital techniques and the necessary codec may be incorporated in them.

It is paradoxical that the appropriate technology for the developing countries in telecommunication equipment is the latest and most modern, not one in vogue a few years ago.

The advent of satellite communication in the '60s brought a new world order in international telecommunications. It broke down the difference between the cities of the developed and developing countries. The unfinished part of the revolution will be completed if satellite communications are used to bridge the gap between the different strata of the same society, the rich and the poor, the urban and the rural.

Cost of the scheme

Such a revolution is already under way and the experiences gained so far in Algeria, Sudan, India and Indonesia as well as the well-known Alaskan experiments have paved the way for a concerted drive by the international commu-

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Year	Trade Import & Non-Oil Export		International Telephone Calls		International Telex Calls	
	Value KD	% Increase over previous Year	Minutes	% Increase over previous Year	Minutes	% Increase over previous Year
1971	266,690					
1972	311,773	16.8				
1973	380,505	22.0	2,060,434		717,077	
1974	572,269	50.0	3,207,060	55.7	1,129,030	57.5
1975	863,976	50.0	4,487,749	39.9	1,867,708	65.37
1976	1,187,628	37.5	4,861,879	8.0	2,985,344	59.8
1977	1,636,000	37.7	7,005,515	44.07	3,472,732	16.3
1978			13,085,754	86.7	4,505,175	29.7

TABLE 2 *The correlation between (non-oil) trade and telecommunications services.*

nity to complete the task of total rural telecommunication development.

The telecommunication network for the rural sectors of developing countries must follow a recognized pattern and should form part of the global network. The starting point of a rural network will therefore be a small town or a similar location which is already a part of the national microwave network of the country's terrestrial plan. Where such facilities are non-existent, the easier and the most economical means is to install a small diameter antenna for satellite communication.

A digital exchange associated with this terminal can cater to several branch routes with remote switching units (concentrators). The circuits to each branch will conform to a few selected choices in analog and digital techniques and the medium used may be freely chosen from several alternatives, the particular choice depending on the circumstances.

The broadband facilities, for which adequate technology already exists, are left out of the scope in order to keep the aims at an economical and practical level for rapid implementation. According to present day techniques, each local exchange can cater to an area of about 80 km radius utilizing PCM (pulse code modulation) systems and concentrators. From each concentrator overhead or underground lines can be extended to subscribers' sets. Where the number of subscribers is less, analog carrier system or narrow band VHF or UHF systems with multiple access facilities can be employed. The exchange also can provide service to a remote community through conventional radio circuits.

It also is possible to design the subscriber terminal with the necessary codec and timing circuits in order to multiplex several terminals over a common pair on a time division basis.

It has been estimated that 80% of the cost in rural telecommunications is in providing the external plant or the so called route costs. The common merit in all the above options is in reducing the per station route costs for the subscriber without reducing the quality. One other aim is to make the same circuit yield multiple uses as telephone, record and facsimile.

With the combined talent of the world, considerable economy can be achieved for an extensive coverage of the rural areas.

The community TV and the cable TV system also can be incorporated, wherever feasible, in the scheme.

The reason why the governments of the world are not embarking on a large scale rural telecommunication program is the relatively high cost and the meager anticipated return on investment. And yet telecommunication engineers, accustomed to engineering projects, are aware of the wide range in costs for various alternatives. And the first step in reducing costs is to make a start. We all are aware of the phenomenal decrease in costs of space segment provided by INTELSAT for international telephone communication. Starting with $32,000 in 1965 per half circuit per year it is now $5760, in spite of the depreciation in the dollar and in real value of money.

If the suggestion for standardization and mass production of equipment is followed on a global basis, there will be few areas where the scheme cannot be economically feasible. The large increase in the satellite circuits in the global network again illustrates the interacting effects of increasing growth and reducing costs.

The example of INTELSAT is noteworthy in another instance as well. This high technology device started exclusively with the most advanced countries of the world. But within a decade, the participation of the developing countries increased progressively, if not in the manufacture of the equipment, at least in the better utilization of the benefits. Whereas in 1971 the top eight countries (consisting of USA, UK, France, West Germany, Japan, Italy, Canada and Australia) controlled about 80% of satellite utilization, in 1979, their cumulative share came down to 57.3%. Because there is a great scope for developing countries to improve their telecommunications, this process is bound to continue. We can reasonably expect a similar situation where rural areas are concerned in relation to their more fortunate cities, once the rural telecommunication scheme gets under way.

We have mentioned that, in remote areas, communication by a domestic satellite or dedicated transponder should be seen as the feasible solution. The cost of the small diameter antenna has been generally reported to be around $50,000 to $100,000. But in 1975 when an experimental rural television program was conducted in India through ATS-6 Satellite, the antennas were prepared indigenously at $300 to $350. Reduction of costs for fixed antenna, constructed with compacted mud and cement plaster and lined with aluminum dish brought the figure to $150 each.

This is one reason why, in a program of this kind, there must be a plan for the manufacture of the maximum numbers of components in the developing countries, where the costs are low and the inflationary effects of advanced countries are not passed on to the developing ones.

A look at Table 3 will indicate the scale of expenditure, and how unrealistic is the talk of costs in the face of the much publicized global interests in assistance to developing countries. The countries are chosen at random, and it should not be constructed that they are specifically singled out for any special mention. They fall in to three categories. Section A consists of developed countries which are reaching saturation in telecommunication facilities and have consequently a lower rate of growth. Yet their investments in telecommunication projects run into thousands of millions of dollars. Sections B and C show the rate of growth in developing countries. Whereas B shows a comparatively high rate for a small investment, C has little hope of advancement due to paucity of funds.

And because telecommunication development is vital to the well being of the international community, it should be subsidized by the state and provided uniformly in a country. And if individual countries are unable to do it without help, the world community should come forward to do it. A little help from the advanced countries of the world will go a long way to our cherished goal of global telecommunication development. Once started, telecommunication always pays its way both by direct and indirect returns.

Power supply for the remote terminals is another constraint to rural telecommunication development. From the dawn of the telecommunication industry, this problem has been faced by telecommunication engineers, who pioneered the modern revolution in areas where electricity had not penetrated. Thanks to the modern energy crisis, sufficient development has already taken place in unconventional power supply designs which are capable of unattended operation using readily available sources of energy. Development of solar energy techniques alone has produced a revolutionary change in the concept and design of networks, whose real potential will be realized only in years to come.

Fortunately in the recent times several hitherto neglected areas have come to demand increasing attention from the administrators and social planners. The developments in the Middle East point to the urgent need of improving conditions in the less privileged areas. The Arabsat is a venture designed primarily to bring about a social integration of urban and rural areas in all the countries of the Arab world. The trend in the Indian subcontinent also is for rapid development of the rural sectors. Consequently large allocations are being made for rural telecommunications in countries as far separated as in the Indian sub-continent, in the Middle East and in South America.

If the developing countries are called upon to purchase standardized equipment from the established manufacturers of the telecommunication industry and install them, we may be sure that their enthusiasm will be much less because of their lack of participation. It would be prudent, as well as pragmatic, to decentralize the efforts and secure the cooperation of all countries on a regional basis for design, manufacture and installation of the telecommunication network.

For the development to take place on any significant scale, the penetration of telecommunications in the rural sectors should be rapid. From the present number of less than one telephone for every 1000 population in the majority of the rural areas of developing countries, a target figure of at least one telephone for every 100 population (subject to a minimum of one for each village) should be achieved in 10 years. Here, it should be understood that the telephone will represent the integrated voice/record facility which was discussed earlier. Considering that in the Alaskan experiment every community of 25 people was provided with a satellite earth station, this target should be seen as a modest and feasible achievement. In areas of relative prosperity where telecommunications have already made headway, in towns and cities of developing countries a more significant target should be set.

The scale of installations and the appropriate costs of the scheme are easily calculated from the information already available. If these costs are too much for the industry to bear, the state should subsidize in the interests of national development. And because the world has a stake in the uniform development of telecommunications all over, the world community must take a hand in implementing these proposals.

These proposals are not new to the world community. All the requirements have been analyzed in many seminars all over the world.

	Country	Total No. of Telephones end 77	No. of Telephones Per 100 Population	Rate of Increase In One Year	Average Annual Investment Million $
A	Japan	49,697,000	42.6	6.4%	6746
	West Germany	22,900,000	34.4	8.0%	2023
	Italy	16,146,000	27.1	5.1%	1676
	Switzerland	4,140,000	63.8	2.6%	429
B	India	2,025,932	0.3	15.4%	305
	Korea	1,681,254	5.0	20.1%	439
	Kuwait	155,000	13.0	10.0%	52
C	Ethiopia	79,000	0.3		23
	Malawi	21,820	0.4		4
	Oman	19,000	0.5		8

TABLE 3 *The scale of expenditures for telecommunications in developed and undeveloped countries.*

And because there is a general desire to expand global telecommunications, I believe that the time has arrived to take decisive action.

I would like to stress that implementation is the key word in this process. What are the methods of achieving results expeditiously? One way is to allow ideas to germinate and actions to follow in their natural sequence. Judging from the economic conditions in the developing countries and the rate of "progress" achieved so far, this is a sure road to disaster. The other alternative is for a world body like ITU to take the initiative and form an organization for implementation, both on a global and regional level. Besides ensuring progress on an international level and benefiting the developing countries, the process will ensure an important role for ITU to play in this exciting task.

I suggest that a Telecommunication Development Council be formed consisting of ITU, INTELSAT, the World Bank or its subsidiaries, representatives of the design and manufacturing interests and representatives of developing countries to initiate action and follow progress.

This Council will form regional bodies to decentralize activity and ensure uniform and rapid development all over the world. The Regional boards, wherein all the telecommunication administrations of the region will be members, will work in close cooperation.

Joint ventures can be set up in the several regions of the world for mass production of the standardized telecommunication equipment, the joint venture involving the countries of the region and representatives of telecommunication manufacturing industries. The selected industries may be dispersed among the countries of the region to promote uniform development and to create a sense of interdependence for their total needs. The staff for the manufacturing industries, for installation and maintenance, could be drawn from the countries of the region on an equitable scale. Working together they will pave the way for better regional understanding and a capacity to work together.

These will allocate the priorities for setting up of industries among the constituent countries, determine their needs and resources available, assign priorities and execute the projects in such a manner that a uniform development is achieved among the countries of the region.

The World Administrative Radio Conference (WARC) has an onerous task in this area (see page 49). When frequencies are allocated, specific provisions must be made in each band for the spread of telecommunications facilities in the developing countries and for rural telecommunications in particular. I hope that the world body takes firm decisions along the lines I have suggested. □

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ANUARY 14, 1980

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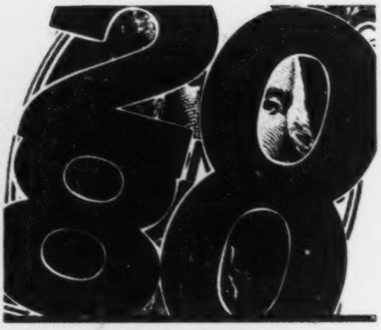
THE JOURNAL OF THE TELEPHONE INDUSTRY SINCE 1901

Telco construction spending to top $20 billion in '80

New decade begins with new high in planned expenditures, but it's not enough to keep up with inflation; top executives look ahead to the 'information system age'

Leo Anderson, Editor, and Gerry Barrett, Special Projects Director



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PREDICTIONS point to construction expenditures of more than $20 billion by the U.S. telephone industry in the first year of the new decade.

MOVING into the decade of the 1980s the U.S. telephone industry passes two significant milestones: (1) its projected construction expenditures for the first year of the new decade are well over $20 billion, a record high; and (2) total telephones in use reached 175 million.

The expected construction spending total for 1980 is $20,921,000,000, which will be $1,076,000,000 higher than the estimated 1979 total of $19,845,000,000. While telco spending is massive—and massively increased for 1980—it is not keeping pace with inflation. The projected increase over 1979 is 5.4%, while the consumer price index (CPI), the most common inflation yardstick, was advancing at an annual rate of 11.2% at year end.

Both the Bell and Independent segments of the telephone industry foresee record construction spending for the year, but the increases are at a lower rate than in the immediate past. The Bell System's $16,660,000,000 construction spending total for 1980 is 4.7% over 1979's $15.9 billion; that compares with a 14% increase in 1979 over 1978. On the Independent side, 1980 spending is expected to be $4,261,000,000, compared to $3,935,000,000 in 1979. That's an 8.3% increase, but in 1979 spending was increased 13.4% over 1978. (See Table 1 for details.)

American Telephone & Telegraph Co. (AT&T) provided information for these statistics, as well as the 22 largest Independent telephone companies. The large independents participating represent 87.9% of the gross plant investment of the total Independent segment. Further data were provided by the U.S. Independent Telephone Assn. (USITA), enabling TELEPHONY to provide totals covering the entire U.S. telephone industry.

Major executives of 13 top telephone systems and companies also commented on industry trends to add further depth to this survey article. Those statements covered such factors as the effect of the current economic downturn on the industry (expected to be mild), technological advancements and their effects, deregulation and increasing competition, the effects of inflation, the consumerism trend, usage sensitive pricing, inter-city pricing changes and their effects on local service pricing, increasing need for—and scarcity of—highly skilled employes, changes in distribution

Table 1 Independent and Bell Construction Expenditures

	Independent Telephone Companies (millions of dollars)**			Bell Telephone Companies (millions of dollars)***			Combined Independent & Bell Telephone Companies (millions of dollars)		
	Const. Spending	Increase (Decrease) vs. Previous Year	% Increase (Decrease)	Const. Spending	Increase (Decrease) vs. Previous Year	% Increase (Decrease)	Const. Spending	Increase (Decrease) vs. Previous Year	% Increase (Decrease)
1958	$ 488	$—	—	$2,241	$—	—	$2,729	$—	—
1959	507	19	3.9	2,297	56	2.5	2,804	75	2.7
1960	565	58	11.4	2,710	413	18.0	3,275	471	16.8
1961	566	1	—	2,759	49	1.8	3,325	50	1.5
1962	619	53	8.6	3,044	285	10.3	3,663	338	10.2
1963	677	58	9.4	3,204	160	5.3	3,881	218	6.0
1964	780	103	15.2	3,566	362	11.3	4,346	465	12.0
1965	928	148	19.0	3,960	394	11.0	4,888	542	12.5
1966	1,130	202	21.8	4,248	288	7.3	5,378	490	10.0
1967	1,254	124	11.0	4,359	111	2.6	5,613	235	4.4
1968	1,366	112	8.9	4,812	453	10.4	6,178	565	10.1
1969	1,560	194	14.2	5,820	1,008	20.9	7,380	1,202	19.5
1970	1,665	105	6.7	7,314	1,494	25.7	8,979	1,599	21.7
1971	1,953	288	17.3	7,728	414	5.7	9,681	702	7.8
1972	2,053	100	5.1	8,483	755	9.8	10,536	855	8.8
1973	2,325	272	13.2	9,516	1,033	10.9	11,841	1,305	12.4
1974	2,618	293	12.6	10,283	767	8.1	12,901	1,060	9.0
1975	2,422	(196)	(7.4)	9,525	(758)	(7.4)	11,947	(954)	(7.4)
1976	2,481	59	2.4	10,044	519	5.5	12,525	578	4.9
1977	2,797	316	12.7	11,793	1,749	17.4	14,590	2,065	16.5
1978	3,471	674	24.1	13,951	2,158	18.3	17,422	2,832	19.4
1979	3,935*	464*	13.4*	15,910*	1,959*	14*	19,845*	2,423*	13.9*
1980	4,261*	326*	8.3*	16,660*	750*	4.7*	20,921*	1,076*	5.4*

*Estimated

**Source: USITA

***Source: AT&T (Bell Telephone Companies include AT&T, its principal telephone subsidiaries, and Bell affiliates, Southern New England Telephone Co. and Cincinnati Bell, whose common stocks are minority-owned by AT&T.)

and ownership of terminal equipment, high interest costs, expected changes in communications law, and the increasing need for marketing orientation among telephone companies and the executives who run them.

Statements of the executives commenting on these trends appear as a series of mini-articles beginning on page 47. A view of long range industry trends was expressed by Alan C. Hasselwander, vice president of corporate planning & development at Rochester (N.Y.) Telephone Corp.:

"The shape of the telecommunications industry will change dramatically in the upcoming decades. A new industry may evolve from the fusing of telecommunications with data processing . . . Rapid changes in technology will require increasingly sophisticated skill levels on the part of engineers, technicians and managers. The capability of our human resources will be the most critical element to success in telecommunications."

Looking even further into the future, William J. Umphred, president of Commonwealth Telephone Co., Dallas, Pa., said: "As we look to the '80s and beyond, we must restructure our planning process and investment decision to accommodate the needs of the information system age. We must become responsive, marketing-oriented organizations. Those companies which have the courage to innovate and adapt to change will survive the communications explosion. Many will prosper from it. And some may well be blown away by it."

Commenting on the more immediate view was Robert P. Reuss, chairman of Central Telephone & Utilities Corp., Chicago, Ill.: "In looking at the challenges facing the industry during 1980, the protection of the integrated toll network must be considered a major objective . . . In addition, because of the thrust of competition, the prospect of deregulation and in anticipation of dramatic technological advances, our operations must become more market-oriented. We will have to plan strategically to meet rapid change . . ."

175 million phones

As the year began, total telephones in the U.S. were estimated at 175 million, of which 80.9% were Bell System phones and the rest Independent. The Bell System total was 141.6 million, an increase of 4.16 million over a year ago. The Independent segment's year-end '79 total was 33.4 million, up 1.8 million over '78. The Independents, thus, are growing at a faster rate than Bell, with Independent phones increasing 5.8% in 1979 over 1978, and Bell phones increasing 3% in the same period. This continues a trend of many years' standing.

USITA, which provides overall Independent statistics for this article, also estimates 1980 year-end totals. It estimates Independent telephones will increase another 1.7 million during the year to 35.1 million, a 5% gain.

Another major yardstick—investment in total telephone plant—increased by $9.8 billion in the Bell System, from $110.5 billion to $120.3 billion, for the 12 months ended Nov. 30 for both 1978 and 1979. Gross plant investment for Independents is estimated to increase to $34.6 billion in 1980, up $3.3 billion from $31.3 billion last year.

The Bell System operating com-

Continued on page 36

pany work force increased by 34,741 to 857,900 as of Nov. 30, 1979, which compares with 823,159 at the same date in 1978. This continues a three-year trend in the System. Previously—in 1974-76—Bell System employment experienced a downtrend. Independent segment employment continues a five-year trend of increases, with the number of employes expected to reach 200,000 in 1980, up 8000 over the 192,000 of last year.

Operating revenues for the Bell System rose to $45 billion in 1979 (12 months ended Nov. 30) compared to $41.9 billion the previous 12 months. USITA estimates the Independents' operating revenues will increase $1.1 billion, to $10.3 billion in 1980, compared to $9.2 billion in revenue last year.

The number of Independent telephone exchanges also is expected to rise by 10, to 11,070 in 1980, compared with 11,060 in '79. Continuing a small, steady decline, Bell System exchanges went down to 6703 in 1979, from 6705 in 1978.

Minus 20 telcos

While all other Independent statistics experience an uptrend, the number of individual Independent telephone companies continues to decline. USITA estimates that mergers and acquisitions will result in the disappearance as separate entities of 20 telcos during 1980. Total Independent telcos, thus, will drop to 1480 from the 1979

Continued on page 38

Table 2 Independent Telephone Company Statistics

Number of Telephones, United States (000 omitted)

	Year-End Total	Increase
1964	14,127	—
1968	18,125	3,998
1972	23,187	5,062
1973	24,782	1,595
1974	25,286	1,044
10-year Growth 11,699=82.8% of year-end '64		
1975	26,823	997
1976	28,209	1,386
1977	29,675	1,466
1978	31,549	1,874
1979	33,400*	1,851*
1980	35,100*	1,700*

Number of Independent Telephone Exchanges

	Year-End Total	Increase
1964	10,696	—
1968	10,889	193
1972	11,104	215
1973	11,106	2
1974	11,048	−58
10-year Growth 352=3.2% of year-end '64		
1975	11,057	9
1976	11,040	−17
1977	11,045	5
1978	11,053	8
1979	11,060*	7*
1980	11,070*	10*

*Estimated
Source: USITA

Number of Independent Telephone Companies

	Year-End Total	Decrease
1964	2,534	—
1968	1,970	564
1972	1,760	210
1973	1,697	63
1974	1,641	56
10-year Decrease 887=35% of year-end '64		
1975	1,618	23
1976	1,590	28
1977	1,556	34
1978	1,527	29
1979	1,500*	27*
1980	1,480*	20*

Investment in Gross Plant ($000,000 omitted)

	Year-End Total	Increase
1964	$ 6,103	—
1968	9,774	3,671
1972	15,555	5,781
1973	17,418	1,861
1974	19,600	2,182
10-year Growth $13,491=221.1% of year-end '64		
1975	21,200	1,600
1976	23,000	1,800
1977	25,130	2,130
1978	27,788	2,658
1979	31,315*	3,527*
1980	34,661*	3,346*

Total Operating Revenues ($000,000 omitted)

	Year-End Total	Increase
1964	$ 1,493	—
1968	2,261	760
1972	3,788	1,521
1973	4,316	528
1974	4,920	604
10-year Growth $3,421=229.5% of 1964 Revenues		
1975	5,500	580
1976	6,300	800
1977	7,115	815
1978	8,085	970
1979	9,237*	1,152*
1980	10,356*	1,119*

Employes

	Year-End Total	Increase
1964	100,766	—
1968	129,430	28,664
1972	155,000	25,570
1973	161,000	6,000
1974	163,000	2,000
10-year Growth 62,234=61.7% of year-end '64		
1975	158,000	−5,000
1976	160,000	2,000
1977	167,000	7,000
1978	179,000	12,000
1979	192,000*	13,000*
1980	200,000*	8,000*

*Estimated
Source: USITA

Table 3 Bell System Statistics*

Number of Telephones (000 omitted)**

	Year-End Total	Increase
1968	91,122	——
1969	95,943	4,821
1970	99,903	3,960
1971	103,699	3,796
1972	108,811	5,112
1973	113,935	5,124
1974	117,732	3,797
1975	121,799	4,067
1976	126,612	4,813
1977	132,397	5,785
1978	137,478	5,081
10-year Growth 46,356 = 50.9% of year-end '68		
1979	141,638‡	4,160‡

Investment in Total Telephone Plant ($000,000 omitted)

	Year-End Total	Increase
1968	$ 46,092	$ ——
1969	50,480	4,388
1970	56,171	5,691
1971	62,049	5,878
1972	68,446	6,397
1973	75,479	7,033
1974	82,683	7,204
1975	89,195	6,512
1976	95,798	6,603
1977	103,576	7,778
1978	110,501	6,925
10-year Growth $64,409 = 139.7% of year-end '68		
1979	120,321‡	9,820‡

Bell System Exchanges

	Year-End Total	Increase/ Decrease
1968	6,762	——
1969	6,764	+ 2
1970	6,769	+ 5
1971	6,761	- 8
1972	6,740	-21
1973	6,734	- 6
1974	6,728	- 6
1975	6,722	- 6
1976	6,713	- 9
1977	6,711	- 2
1978	6,705	- 6
1979	6,703†	- 2†

Operating Revenues ($000,000 omitted)

	Year-End Total	Increase
1968	$14,429	$ ——
1969	16,057	1,628
1970	17,369	1,312
1971	18,885	1,516
1972	21,404	2,519
1973	24,089	2,685
1974	26,769	2,680
1975	29,569	2,800
1976	33,493	3,924
1977	37,247	3,754
1978	41,945	4,698
10-year Growth $27,516 = 190.7% of year-end '68		
1979	45,050‡	3,105‡

Operating Company Employes

	Year-End Total	Increase/ Decrease
1968	696,749	——
1969	755,065	+58,316
1970	793,196	+38,131
1971	796,472	+ 3,237
1972	797,202	+ 730
1973	818,168	+20,966
1974	812,139	− 6,029
1975	788,619	−23,520
1976	777,721	−10,898
1977	785,378	+ 7,657
1978	823,159	+37,781
10-year Growth 126,410 = 181.4% of year-end '68		
1979	857,900‡	+34,741‡

*Bell System includes AT&T, its principal telephone subsidiaries, and Bell affiliates (Southern New England Telephone Co. and Cincinnati Bell) whose common stocks are minority-owned by AT&T.

**Includes Bell Service Telephones

†Estimated

‡12 months ended Nov. 30.

Source: AT&T

Table 4 Independent Telephone Company Composite Plant Statistics ($000,000 Omitted)

Buildings

	Year-End Total	Increase
1968	$ 660.5	$—
1969	745	84.5
1970	828.5	83.5
1971	923	94.5
1972	1,028	105
1973	1,117.8	89.8
1974	1,230.8	113
1975	1,344.8	114
1976	1,439.4	94.6
1977	1,523.4	84
1978	1.644.3	120.9

10-year Growth
$983.8 = 148.9% of year-end '68

Aerial Cable

	Year-End Total	Increase
1968	$1,360	$—
1969	1,460	100
1970	1,590	130
1971	1,747	157
1972	1,875	128
1973	2,010.4	135.4
1974	2,112.5	102.1
1975	2,216.8	104.3
1976	2,359.5	142.7
1977	2,516.4	156.9
1978	2,697.6	181.2

10-year Growth
$1,337.6 = 98.4% of year-end '68

Central Office Equipment

	Year-End Total	Increase
1968	$2,895	$—
1969	3,350	455
1970	3,797	447
1971	4,365	568
1972	5,017	652
1973	5,662.8	645.8
1974	6,163	500.2
1975	6,763	600
1976	7,542.8	779.8
1977	8,169.8	627
1978	8,963.8	794

10-year Growth
$6,068.8 = 209.6% of year-end '68

Underground Cable

	Year-End Total	Increase
1968	$ 438.3	$—
1969	483	44.7
1970	540	57.0
1971	608.5	68.5
1972	670	61.5
1973	734.3	64.3
1974	783	48.7
1975	841.1	58.1
1976	910.1	69.0
1977	975.5	65.4
1978	1,081.5	106.0

10-year Growth
$643.2 = 146.7% of year-end '68

Station Apparatus

	Year-End Total	Increase
1968	$1,018	$—
1969	1,140	122
1970	1,256	116
1971	1,367	111
1972	1,503	136
1973	1,672.9	169.9
1974	1,794.1	121.2
1975	1,905	110.9
1976	2,058.3	153.3
1977	2,275.4	217.1
1978	2,536.4	261.0

10-year Growth
$1,518.4 = 149.2% of year-end '68

Buried Cable (Plowed In)

	Year-End Total	Increase
1968	$ 592.5	$—
1969	753	160.5
1970	960.5	207.5
1971	1,220	259.5
1972	1,510	290
1973	1,827	317
1974	2,193.2	366.2
1975	2,393.3	200.1
1976	2,851.2	457.9
1977	3,219.4	368.2
1978	3,654.5	435.1

10-year Growth
$3,062.0 = 516.8% of year-end '68

Large Private Branch Exchanges

	Year-End Total	Increase
1968	$228.3	$—
1969	278	49.7
1970	317.7	39.7
1971	362.6	44.9
1972	406.7	44.1
1973	460.7	54.0
1974	496.1	35.4
1975	531.3	35.2
1976	598.5	67.2
1977	660.3	61.8
1978	726.2	65.9

10-year Growth
$497.9 = 218% of year-end '68

Underground Conduit

	Year-End Total	Increase
1968	$241.7	$—
1969	278	36.3
1970	320	42
1971	365	45
1972	406.3	41.3
1973	457.4	51.1
1974	494.1	36.7
1975	518.6	24.5
1976	566.5	47.9
1977	606.8	40.3
1978	664.5	57.7

10-year Growth
$422.8 = 174.9% of year-end '68

Vehicles, Other Work Equipment

	Year-End Total	Increase
1968	$195.1	$—
1969	221	25.9
1970	248	27
1971	281.9	33.9
1972	302	20.1
1973	338.1	36.1
1974	357	18.9
1975	365.1	8.1
1976	404.4	39.3
1977	459.9	55.5
1978	550.6	90.7

10-year Growth
$355.5 = 182.2% of year-end '68

Source: USITA (Extrapolated by TELEPHONY to 100% of Independent companies.)

figure of 1500. Major mergers completed during 1979 included three of the top 25 Independents. The biggest of these—Winter Park (Fla.) Telephone Co., with 165,900 stations—was acquired by United Telecommunications, Inc., Kansas City, Mo., the second largest Independent telephone holding company in the country. The other two top-25 acquisitions both became part of Mid-Continent Telephone Corp., Hudson, Ohio, fifth largest Independent holding company. Those acquisitions were Telephone Utilities of Pennsylvania, Export, Pa., with 99,400 telephones; and Newark (Ohio) Telephone Co., with 52,200 phones. Twenty-four other mergers, in addition to these three, took place during the year.

Of the 22 Independent telcos reporting to us for this survey (who represent 87.9% of the total Independent industry), 17 report that they spent more on construction in 1979 than in 1978. Four companies spent less, and one spent the same amount both years. Looking ahead to 1980, all but four of the 22 say their expenditures will increase this year. (See Table 6 on page 46.)

All of the top five companies of the 22 report increases in construction spending in 1979, with Mid-Continent spending 26% more than in '78, Continental 20.5%, United 20%, General Telephone 11.1% and Central .6%. Among the four reporting lower spending for 1979 decreases ranged from 25.7% to 8%. The highest increase reported among all 22 was 62% by Universal Telephone, Milwaukee.

Budgets this year are up for 18 of the 22 companies, with increases ranging from 3.4% to 58.8%. Decreases among the four which are budgeting less than in '79 range from 3.4% to 23.4%. All of the top five companies expect increased construction spending for the year: General up 10%, United up 4.3%, Continental up 16.7%, Central up 11.8% and Mid-Continent up 23.4%.

For '81, 11 of the 22 project budget increases above this year's, with those increases ranging from less than 1% to a high of 28.8%. Two companies would not venture a prediction for 1981; three companies say they'll spend the same next year as this, and six say their spending will go down. Among the top companies, General and United predict increased construction spending of 9% and 6% respectively for 1981 over 1980. Continental projects a decrease of 2%.

For the Bell operating companies—always more chary of providing advance spending estimates than the Independents—the construction figures are shown in Table 7 on page 46. All Bell operating units spent more on construction in 1979 than in '78, and all but one have budgeted more for '80 than '79. Indiana Bell expects to spend the same this year as last. The total for 1980 for the Bell companies and affiliates is $17 billion, up $1.1 billion over 1979. (See Table 7.)

Changes in the industry's plant makeup over the past ten years are shown in Table 4 for the Independents and Table 5 for the Bell System.

The Independent statistics trace growth in these categories: buildings, underground cable, PBXs, aerial cable, station apparatus, underground conduit, central office equipment, buried cable and vehicles. Highest percentage growth over the 10 years 1968-78 was in buried (plowed-in) cable—up 516.8%. Other high-growth categories during the ten years: PBXs, up 218%; and central office equipment, up 209.6%. There has been a fall-off in percentage of growth in all categories in the 1968-78 period compared to 1967-77 except for station apparatus and for vehicles.

Buried cable (plowed-in) also showed the highest 10-year percentage growth in the Bell System (318.9%). Other high-growth categories were: underground conduit, up 202.4% in the ten years; and vehicles and other work equipment, up 187.7%.

Looking at the top investment categories of the two segments of the industry indicates some of the historic and continuing differences in their types of operation. Both Bell and Independents have their greatest investment in central office equipment. But number two category for the Independents is buried cable, and number three is still aerial cable. Number two investment category for Bell is station equipment, and number three is buildings. ☐

(Tables 6 and 7 appear on page 46 of this issue.—Ed.)

Table 5 Bell System Composite Plant Statistics ($000,000 Omitted) (Source AT&T)

Buildings

	Year-End Total	Increase
1968	$4,106	$—
1969	4,441	335
1970	4,917	476
1971	5,507	590
1972	6,157	650
1973	6,913	756
1974	7,569	656
1975	8,266	697
1976	8,950	684
1977	9,553	603
1978	10,080	527

10-year Growth
$5,974=145.5% of year-end '68

Large Private Branch Exchanges

	Year-End Total	Increase
1968	$1,781	$—
1969	2,008	227
1970	2,237	229
1971	2,442	205
1972	2,645	203
1973	2,842	197
1974	3,030	188
1975	3,167	137
1976	3,230	63
1977	3,256	26
1978	3,300	44

10-year Growth
$1,519=85.3% of year-end '68

Underground Cable

	Year-End Total	Increase
1968	$2,933	$—
1969	3,191	258
1970	3,536	345
1971	3,967	431
1972	4,395	428
1973	4,874	479
1974	5,419	545
1975	5,864	445
1976	6,262	398
1977	6,760	498
1978	7,393	633

10-year Growth
$4,460=152% of year-end '68

Aerial Cable

	Year-End Total	Increase
1968	$4,438	$—
1969	4,683	245
1970	4,944	261
1971	5,206	262
1972	5,520	314
1973	5,894	374
1974	6,283	389
1975	6,673	390
1976	7,126	453
1977	7,659	533
1978	8,258	599

10-year Growth
$3,820=86% of year-end '68

Station Apparatus

	Year-End Total	Increase
1968	$3,867	$—
1969	4,293	426
1970	4,641	348
1971	4,879	238
1972	5,303	424
1973	5,753	450
1974	6,125	372
1975	6,636	511
1976	7,238	602
1977	8,039	801
1978	9,026	987

10-year Growth
$5,519=133.4% of year-end '68

Buried Cable (Plowed In)

	Year-End Total	Increase
1968	$2,249	$—
1969	2,696	447
1970	3,163	467
1971	3,721	558
1972	4,269	548
1973	4,930	661
1974	5,757	827
1975	6,593	836
1976	7,357	764
1977	8,283	926
1978	9,421	1,138

10-year Growth
$7,172=318.9% of year-end '68

Central Office Equipment

	Year-End Total	Increase
1968	$16,242	$—
1969	17,805	1,563
1970	19,628	1,823
1971	22,020	2,392
1972	24,692	2,672
1973	27,541	2,849
1974	30,356	2,815
1975	33,098	2,742
1976	35,351	2,253
1977	37[illegible]	2,363
1978	40,[illegible]	2,689

10-year Growth
$24,161=148.8% of year-end '68

Vehicles & Other Work Equipment

	Year-End Total	Increase
1968	$ 538	$—
1969	596	58
1970	696	100
1971	773	77
1972	862	89
1973	971	109
1974	1,069	98
1975	1,122	53
1976	1,225	103
1977	1,365	140
1978	1,548	183

10-year Growth
$1,010=187.7% of year-end '68

Underground Conduit

	Year-End Total	Increase
1968	$1,716	$—
1969	1,891	175
1970	2,165	274
1971	2,459	294
1972	2,772	313
1973	3,162	396
1974	3,635	467
1975	3,975	340
1976	4,266	291
1977	4,646	380
1978	5,189	543

10-year Growth
$3,473=202.4% of year-end '68

Total Station Equipment

	Year-End Total	Increase
1968	$9,386	$—
1969	10,418	1,032
1970	11,376	958
1971	12,245	869
1972	13,344	1,099
1973	14,501	1,157
1974	15,578	1,077
1975	16,769	1,191
1976	18,117	1,348
1977	1[illegible],835	1,718
1978	21,974	2,139

10-year Growth
$12,588=134.1% of year-end '68

Table 6 Construction Spending of Major Independents, plus other '79 Year-End Estimated Figures
(dollar figures are in millions)

Company	No. of Stations	Plant Investment	Operating Revenues ('79)	Construction Expenditures			
				Spent 1978	Budgeted or estimated 1979	1980	1981
General Tel. & Electronics Corp.	15,100,000	$14,400.0	$4,400.0	$1,800.0	$2,000.0	$2,200.0	$2,400.0
United Telecom., Inc.	4,486,204	4,231.0	1,280.0	457.4	548.7	572.0	606.7
Continental Tel. Corp.	2,999,685	3,100.0	892.3	319.6*	385.0	449.2	439.8
Central Tel. & Utilities Corp.	1,856,000	1,582.0	529.6	175.8	176.6	197.4	NA
Mid-Continent Tel. Corp.	1,088,000	968.0	238.0	86.5	109.0	134.5	135.8
Rochester Tel. Corp.	630,588	491.5	171.5	29.6	31.1	35.6	44.3
Puerto Rico Tel. Corp.	583,141	806.9	211.0	75.7	85.0	90.0	90.0
Lincoln Tel. & Tel. Co.	319,300	268.0	82.0	30.2	30.2	34.2	37.6
Century Tel. Enterprises, Inc.	246,000	276.7	51.8	20.4	29.0	31.5	36.3
Commonwealth Tel. Co.	227,015	164.6	42.9	18.9	17.2	18.2	17.6
Allied Tel. Co.	192,000	197.4	43.4	27.2	25.0	26.0	23.0
Telephone & Data Systems, Inc.	182,850	155.1	36.9	12.6	14.5	15.0	15.6
Telephone Utilities, Inc.	185,000	150.0	53.0	17.7	28.5	35.0	42.8
Anchorage Tel. Utility	135,762	159.9	45.8	31.8	32.5	31.4	36.0
Illinois Consolidated Tel. Co.	125,000	91.5	32.0	8.7	13.7	12.0	12.0
North State Tel. Co.	106,900	58.3	18.5	4.0	5.5	4.0	4.0
Citizens Utilities Co.	100,200	161.6	40.6	26.9	33.1	42.1	NA
The Concord Tel. Co.	89,200	51.2	16.0	4.6	6.0	5.0	5.5
North-West Tel. Co.	72,250	67.8	17.3	10.1	7.5	8.9	8.0
Roseville Tel. Co.	69,200	60.1	16.3	6.4	8.1	10.4	13.4
Universal Tel., Inc.	53,500	47.5	11.9	4.2	6.8	10.8	10.6
Northwestern Tel. Co.	50,000	30.5	9.6	3.4	3.0	4.4	2.9

*Excludes purchased companies

Table 7 Construction Expenditures by Bell Telephone Companies*
(dollar figures are in millions)

Company	Total Telephones 12 Months Ending Nov. 30, 1979	Plant Invest. ($M) 10 Months Ending Oct. 31, 1979	Operating Revenues 12 Months Ending Nov. 30, 1979 ($M)	Construction Expenditures ($M)		
				Spent 1978(2)	Budgeted 1979(1)	1980(1)
New England	6,939,000	5,490	2,020,000	449	560	680
New York	11,916,000	11,720	4,450,000	1,012	1,120	1,210
New Jersey	6,341,000	4,370	1,590,000	425	510	560
Pennsylvania	8,377,000	5,370	1,810,000	573	660	700
Chesapeake & Potomac	8,479,000	6,540	2,230,000	673	820	860
Southern	12,092,000	10,310	3,580,000	1,312	1,550	1,730
South Central	10,293,000	8,850	2,900,000	1,301	1,340	1,350
Ohio	5,005,000	3,460	1,280,000	399	410	420
Michigan	6,302,000	4,540	1,510,000	462	530	560
Indiana	2,653,000	1,900	659,000	189	220	220
Wisconsin	2,411,000	1,740	570,000	188	200	210
Illinois	8,335,000	5,540	2,050,000	583	630	680
Northwestern	5,557,000	4,640	1,520,000	548	600	640
Southwestern	16,089,000	13,530	4,590,000	1,946	2,160	2,220
Mountain	7,458,000	6,300	2,150,000	869	920	1,070
Pacific Northwest Bell	3,808,000	3,280	1,130,000	492	530	550
Pacific T&T	15,828,000	14,040	4,580,000	1,752	2,180	2,300
Bell Operating Cos.	137,883,000	111,620	38,550,000	13,173	14,940	15,960
Long Lines	—	7,730	—	497	650	700
Bell System	137,883,000	111,620	—	13,670	15,590	16,660
Southern New England	2,566,000	NA	680,000	194	220	230
Cincinnati	1,189,000	NA	280,000	87	100	110
All Cos.	141,638,000	119,350	39,510,000	13,951	15,910	17,000

(1) Rounded to nearest ten million dollars
(2) Rounded to nearest one million dollars

* "Bell Telephone Companies" includes AT&T, its principal telephone subsidiaries, and Bell affiliates (Southern New England Telephone Co. and Cincinnati Bell) whose common stocks are minority-owned by AT&T.
Source: AT&T

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DAN S. FARGO, PUBLISHER

World telecom spending to rise 13.3% in 1980 over 1979 spending levels as world turns to technology to solve social, economic problems

Int'l telecom spending levels to increase in '80

WORLD-OUTSIDE-the-United-States telecommunications construction spending is forecasted to jump 13.3% in 1980.

Is this advance due to Telecom 79 and the many other shows last year with their almost magical equipment displays and inspiring programs?; or was it the technical cooperation program of the International Telecommunication Union that sends experts and advisers to enhance communication development all over the world?; was it the pervasive influence for telecom progress found in the industry's trade magazines?; or could it have been the requests and demands of business and residence customers of the world's PTTs? Surely all of these plus more fed the imagination of PTT managers and technical personnel as they planned this ambitious 13.3% move forward for 1980—despite gloomy expectations of a downturn in world business in the midst of continuing crippling inflation.

The gross spending amount for 1980 is $40.456 billion, up from $35.704 billion in 1979, and $33.138 billion in 1978 (see Table A).

With construction expenditures in the United States estimated at $20.921 billion for 1980, this gives a world total of $61.377 billion. That is a rise of 10.5% from 1979's $55.549 billion level. The U.S. contributes only a 5.4% increase to the 1980 amount.

But let's step back for a moment and more carefully analyze that "only a 5.4% increase." A look at earlier U.S. telecom spending shows that there were leaps upward of 19.5% in 1969; 21.7% in 1970; 16.5% in '77; 19.4% in '78, and 13.9% for '79; so we can say U.S. telecom spending leveled off on a rather high plateau.

Similarly, world-other-than-U.S. budgets took a big leap in 1977—26.3%. (Regrettably, our TELEPHONY surveys of worldwide spending only go back to 1975.)

Survey results appear in Tables 1 and 2, pp. 86-103.

Our 1980 estimate is based on extrapolated* survey returns from 82 telecom administrations representing approximately 62.7% of the world-outside-the-U.S.'s estimated 297,000,000 telephones as of Dec. 31, 1979.

A 1981 construction spending estimate—$40.373 billion—can be obtained by extrapolating the '81 returns, but 35.6% really is too narrow a base for a dependable result. And, after all, what are most important are the individual countries' forecasts. Where these are available for 1981, they are useful for indicating the trend ahead.

A word now about the pivotal 297 million non-U.S. phone total mentioned above. We have assumed 6% growth from Dec. 31, 1977's 261,010,000** to obtain 279,440,000 for Dec. 31, 1978; then 6.28% growth in '79 to reach the 297 million mark. (Formerly we'd taken the average of growth rates of the available preceding five years and assumed this was the growth rate for the year just ended. Since this produced a consistently high result, we've scaled the growth rate down for this writing.) Adding in the estimated Dec. 31, 1979 Bell System's 141,638,000 phones and those of the U.S. Independents, 33.4 million, gives a world total of

Continued on page 102

Table A

Annual telecommunication construction spending ($ billions)

	World outside U.S.	Increase	United States	Increase	World Total	Increase
1975	23.837	—	11.947	—	35.784	—
1976	25.450	6.8	12.525	4.8	37.975	6.1
1977	32.140	26.3	14.590	16.5	46.730	23.1
1978	33.138	3.1	17.422	19.4	50.560	8.2
1979	35.704	7.7	19.845	13.9	55.549	9.9
1980	40.456	13.3	20.921	5.4	61.377	10.5

---

*We used our usual "straight extrapolation," which assumes construction expenditures in non-reporting nations were in the same proportion to telephones in place at the end of 1979 as those in reporting nations. Spending amounts for 1978 were received from countries representing 61.4% of non-U.S. phones, for 1979, 62.9%, and 1981, 35.6%. Our annual word of caution: this latter percentage is a narrow base for extrapolation.

**As reported in "The World's Telephones," published by AT&T Long Lines, Overseas Administration, Bedminster, N.J., issued dated December 1978.

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Table 1 World Telephone Totals

	Estimated population 12/31/79 of serving area	Households 12/31/79 (est.)	Businesses 12/31/79 (est.)
North America			
Canada			
Community Tel. Co. of Ontario Ltd., Dunnville	n/a†	n/a	n/a
Edmonton (Alta.) Tels.	497,255	175,709	n/a
Northern Tel. Ltd., New Liskeard, Ont.	121,916	41,099	n/a
Ontario members Can. Ind. Tel. Assoc. excluding Northern Tel. and Ontario Northland Telecom.	310,000	n/a	n/a
Quebec-Telephone, Rimouski	552,000	150,000	27,000
City of Thunder Bay (Ont.) Tel. System	124,500	43,753	2,350
Telebec Ltd., Montreal	n/a	n/a	n/a
Transcanada Telephone System:			
Alberta Government Tels.	1,525,000	435,000	n/a
Bell Canada	13,371,356	4,458,563	n/a
British Columbia Tel. Co.	2,568,000	902,000	147,000
The Island Tel. Co. (Prince Edward Island)	122,800	35,200	n/a
Manitoba Tel. System	1,032,400	328,004	25,886
Maritime T.&T. Co. Ltd. (Nova Scotia)	854,700	247,000	n/a
New Brunswick Tel. Co.	698,700	205,000	18,292
Newfoundland Tel. Co. Ltd.	416,739	104,919	n/a
Saskatchewan Telecommunications	971,510	291,150	n/a
Mexico, Telefonos de	23,010,776	11,964,000	450,000
Middle America			
Bahamas			
Bahamas Telecom. Corp.	231,200	46,240	n/a
Grand Bahama Tel. Co., Ltd.	21,000	6,560	1,250
Barbados	250,000	65,000	n/a
Bermuda	57,810	18,000	4,200
Costa Rica	2,206,922	441,384	n/a
Dominican Republic	5,300,000	n/a	n/a
Puerto Rico Communications Authority	447,000	115,812	7,392
Virgin Islands (U.S.)	101,000	30,122	11,800
South America			
Bolivia			
Bolivian Assoc. of Tel. Cos.	4,956,540	n/a	n/a
Brazil			
Cetel, Rio de Janeiro	2,066,974	470,398	39,571
Telamazon, Manaus	1,342,000	152,493	n/a
Telebahia, Salvador	9,287,000	n/a	n/a
Telemig, Belo Horizonte	8,925,412	1,052,426	125,938
Telepar, Curitiba	9,890,000	827,000	146,000
Telpa, Joao Pessoa	2,902,700	604,729	8,138
Chile	11,010,483	2,105,000	200,000
Colombia			
Emcali, Cali	1,164,764	158,100	17,860
Empresas Publicas de Medellin	2,013,000	324,700	n/a
Ministry of Communications & Telecom	26,586,970	4,506,266	n/a
Peru			
Cia. Peruana, Lima	4,804,866	960,973	n/a

Business telephone main stations 12/31/79 (est.)	Business extension telephone stations 12/31/79 (est.)	Residence telephone main stations 12/31/79 (est.)	Residence extension telephone stations 12/31/79 (est.)	Total telephones 12/31/79 (est.)
2,731	3,436	20,025	6,939	33,131
79,986	80,066	193,527	79,608	433,187
7,289	24,838	37,990	13,518	71,455
n/a	n/a	n/a	n/a	204,082
32,000	30,000	169,000	41,000	268,000
10,823	23,775	42,418	14,445	91,461
16,955	28,600	92,100	18,000	155,655
125,700	219,700	517,350	251,250	1,114,000
1,294,943	1,675,586	4,684,226	1,818,170	9,270,398
168,183	115,522	929,466	317,061	1,777,164
4,350	12,052	36,098	11,612	64,112
69,079	54,289	348,068	126,763	674,883
61,579	64,668	259,698	88,534	474,479
33,605	35,089	201,620	70,407	376,125
23,337	30,957	99,537	39,002	192,833
56,706	41,585	314,124	113,748	594,300
386,756	114,205	982,900	628,810	4,341,656
6,220	22,515	15,781	8,536	53,052
1,712	5,830	3,908	2,381	13,831
6,700	14,300	29,300	3,650	54,100
2,990	16,150	16,665	7,490	43,295
31,720	47,560	90,280	135,420	189,000
22,900	35,000	75,000	15,700	150,000
8,510	11,613	34,965	6,959	62,047
5,100	9,350	17,625	3,875	37,500
n/a	n/a	n/a	n/a	106,100
22,062	5,744	10,667	3,500[7]	41,973[7]
8,435	1,914	18,384	3,900	40,420
n/a	n/a	n/a	n/a	157,660
92,758	126,958	277,611	42,831	542,600
61,700	111,600	133,600	61,500	371,000
8,944	7,635	25,472	1,783	41,053
115,717	161,878	239,033	47,476	564,104[1]
25,235	4,900	47,242	2,100	79,497
34,187	10,256	164,325	49,297	216,500
n/a	n/a	n/a	n/a	1,056,155
37,720	66,270	159,072	34,251	365,170

Continued on page 90

Table 1 World Telephone Totals (continued)

	Estimated population 12/31/79 of serving area	Households 12/31/79 (est.)	Businesses 12/31/79 (est.)
Europe			
Austria	7,500,000	2,700,000	n/a
Denmark			
Fyns Kommunale Telefonselskab, Odense	n/a	190,000	11,000
Telefontilsynet, Copenhagen	5,120,000	2,185,000	n/a
Jydsk Telefon, Arhus	2,090,000	730,000	150,000
Finland	4,719,000[2]	1,603,000	n/a
Germany, Federal Republic of	61,323,000	23,600,000	1,903,000
Greece	9,487,500	3,215,000	n/a
Hungary	10,699,000	n/a	n/a
Iceland	226,000	n/a	n/a
Ireland	3,400,000	850,000	n/a
Malta	314,000	n/a	n/a
Netherlands	14,070,000	4,930,000	500,000
Norway	4,080,743	1,590,000	n/a
Portugal	9,899,300	2,345,225	n/a
Spain	37,150,000	9,750,000	n/a
Sweden	8,300,000	3,400,000	210,000
Switzerland	6,355,000	2,695,000	n/a
United Kingdom[8]	55,769,000	19,846,000	2,200,000
Asia			
Bahrain	365,000	n/a	n/a
Brunei	209,000	n/a	n/a
China/Taiwan	17,535,000	3,577,000	479,000
Cyprus	623,000	157,000	29,000
Hong Kong	4,970,000	1,030,000	220,000
Israel	3,820,000	1,027,000	n/a
Japan	116,890,000[6]	35,891,000	n/a
Kuwait	1,320,000	199,000	28,500
Nepal	12,000,000	2,100,000	n/a
Philippines			
Philippine Long Distance Tel. Co	8,349,906	1,391,651	144,726
Republic Tel. Co., Inc.	n/a	n/a	n/a
Qatar	200,000	34,000	n/a
Telecom Singapore	2,377,383	495,000	68,000
Thailand	46,243,600	7,609,000	460,000
Africa			
Ethiopia	30,000,000	n/a	n/a
South Africa, Republic of	n/a	n/a	n/a
Zimbabwe Rhodesia	7,140,000	940,000	3,500
Oceania			
Australia	14,331,600[9]	4,722,008[9]	n/a
Fiji	613,000[9]	97,233[11]	n/a
Guam	125,000	18,000	9,000
Mariana Islands	113,270	14,000	200
New Zealand	3,144,600	1,066,500	109,759[12]
Pitcairn Island	65	16	0

Business telephone main stations 12/31/79 (est.)	Business extension telephone stations 12/31/79 (est.)	Residence telephone main stations 12/31/79 (est.)	Residence extension telephone stations 12/31/79 (est.)	Total telephones 12/31/79 (est.)
2,034,854	770,000	n/a	n/a	2,804,854
30,000	40,000	143,000	22,000	235,000
n/a	n/a	n/a	n/a	3,080,000
210,000	248,000	602,000	90,000	1,150,000
380,000	578,000	1,270,000	n/a	2,240,000
2,100,000	n/a	19,228,000	7,500,000	26,700,000[2]
620,700	n/a	1,519,770	n/a	2,667,610
203,303	556,545	345,551	65,262	1,180,679
15,000	n/a	64,600	n/a	103,000
186,000	n/a	246,000	n/a	580,000
50,025[3]	n/a	27,305[4]	n/a	77,330
n/a	n/a	n/a	n/a	6,860,000
n/a	432,600	n/a	n/a	1,730,000
n/a	n/a	n/a	n/a	1,300,000
2,263,683	n/a[5]	4,259,901	n/a	11,128,000
725,000	1,980,000	3,972,000	445,000	6,397,000
n/a	n/a	n/a	n/a	4,440,000
3,600,000	6,900,000	14,200,000	2,300,000	27,000,000
10,433	n/a	22,814	n/a	60,424
n/a	n/a	n/a	n/a	15,000
573,000	172,000	1,147,000	190,000	2,595,000
n/a	n/a	n/a	n/a	100,000
280,250	260,150	890,750	86,850	1,518,000
n/a[17]	n/a	n/a	n/a	1,080,000
n/a	n/a	n/a	n/a	53,282,000
53,650	46,400	91,350	11,600	193,000
n/a	2,600	n/a	n/a	12,500
110,495	93,856	193,598	41,088	519,642
8,244	3,100	21,382	1,910	46,822
7,000	n/a	14,000	n/a	31,000[7]
122,014	144,114	342,758	16,244	625,130
140,260	49,090	157,350	55,073	463,000
n/a	n/a	n/a	n/a	90,730
423,000	938,000	1,152,000	55,000	2,605,000
94,849[14]	115,252[15]	n/a	n/a	210,101
1,282,970[10]	n/a	3,166,498[10]	n/a	6,676,576[10]
n/a	n/a	n/a	n/a	37,326
4,000	7,000	11,000	2,000	24,000
885	295	376	60	1,836
176,049	n/a[13]	906,489	n/a[13]	1,762,310
n/a	n/a	n/a	n/a	28

Continued on page 92

Table 1 World Telephone Totals (continued)

	Estimated population 12/31/79 of serving area	Households 12/31/79 (est.)	Businesses 12/31/79 (est.)
Solomon Islands	215,000	n/a	n/a
Tonga	103,000	17,000	146

Footnotes, Table 1

†not available

[1] Est. total tels. for Chile, Est. total tels. for Chile telco 546,974; other telcos: 17,130

[2] Data in Table are for both Finnish PTT and the independent telcos

[3] Includes business extensions

[4] Includes residence extensions

[5] Business extension phones plus residence extensions total 4,451,200

[6] As of March 31, 1980, as is rest of data

Table 2 World Plant Investment, Service Revenues and Construction Expenditures

excluding land and buildings ($ millions)

North America	Est. total telecom plant gross investment 12/31/79	Est. 1979 telephone service revenues	Actual 1978 construction	
			Inside plant	Outside plant
Canada				
Community Tel. Co. of Ontario	21.600	5.206	.684	1.270
Edmonton Tels.	329.678	87.509	14.345	10.245
Northern Tel. Ltd.	41.401	13.983	.598	1.609
Quebec-Telephone	327.000	98.000	n/a†	n/a
Thunder Bay Tel. System	42.000	n/a	.222	1.208
Telebec Ltd.	120.407	40.900	5.934	4.905
Transcanada Tel. System:				
Alberta Govt. Tels.	1,349.612	445.400	100.172	41.670
Bell Canada	7,361.340	2,404.565	235.800	273.000
Island Tel. Co.	49.677	16.171	2.181	2.355
Manitoba Tel. System	555.372	162.576	37.081	19.723
Maritime Tel. & Tel. Co.	414.986	141.392	1.666	12.594
New Brunswick Tel. Co.	356.263	117.173	12.942	10.455
Newfoundland Tel. Co. Ltd.	n/a	n/a	8.999	5.360
Saskatchewan Telecoms	538.645	168.470	28.408	33.185

Business telephone main stations 12/31/79 (est.)	Business extension telephone stations 12/31/79 (est.)	Residence telephone main stations 12/31/79 (est.)	Residence extension telephone stations 12/31/79 (est.)	Total telephones 12/31/79 (est.)
660	630	340	140	1,770
117	71	1,017	49	1,134

[7] TELEPHONY estimate
[8] 12/31/78
[9] 6/30/78
[10] 6/30/79
[11] 12/31/76
[12] Registered companies
[13] Business extension phones plus residence extensions total 669,982
[14] Business main stations plus residence mains
[15] Business extension phones plus residence extensions
[16] 6/30/80
[17] Of Israeli main stations, 24% are business; 76% residence
[18] Telephone totals are as of 10/31/79

expenditures			Budgeted or estimated construction expenditures				
Station apparatus	Other	Total	Inside plant	Outside plant	Station apparatus	Other	Total
.185	.058	2.198	79) .680 80) .410 81) .455	79) .978 80) 1.350 81) .970	79) .136 80) .220 81) .220	79) .043 80) .042 81) .013	79) 1.836 80) 2.022 81) 1.658
19.611	1.613	45.814					79) 47.618 80) 53.515 81) 56.125
.437	1.588	4.232					79) 5.712 80) 5.336 81) 5.515
n/a	n/a	44.000					79) 40.200 80) 44.408 81) 51.000
1.877	.263	3.569	79) .593 80) 4.137 81) .997	79) 1.505 80) 1.517 81) 1.254	79) 1.711 80) 2.701 81) 3.506	79) 1.092 80) .478 81) .391	79) 4.901 80) 8.833 81) 6.148
3.566	1.031	15.436	79) 6.244 80) 7.026 81) n/a	79) 5.563 80) 7.717 81) n/a	79) 4.061 80) 4.323 81) n/a	79) 1.306 80) 2.320 81) n/a	79) 17.174 80) 21.386 81) n/a
52.884	24.051	218.777	79) 90.108 80) 97.436 81) 101.772	79) 46.544 80) 51.548 81) 54.321	79) 80.706 80) 98.683 81) 112.260	79) 55.729 80) 49.441 81) 39.779	79) 273.086 80) 297.107 81) 308.132
225.800	106.400	841.000	79) 273.600 80) 306.500 81) 339.700	79) 283.700 80) 296.600 81) 290.300	79) 280.900 80) 283.300 81) 262.800	79) 120.100 80) 189.800 81) 166.000	79) 958.300 80) 1,076.000 81) 1,058.800
1.343	.382	6.260	79) 1.794 80) 2.954 81) 2.686	79) 2.499 80) 1.794 81) 2.159	79) 1.556 80) 1.891 81) 2.142	79) 1.700 80) 1.352 81) 1.003	79) 7.548 80) 7.990 81) 7.990
14.990	7.100	78.894	79) 18.986 80) 21.728 81) 21.519	79) 20.122 80) 20.987 81) 23.549	79) 15.853 80) 19.749 81) 20.441	79) 3.340 80) 4.054 81) 6.003	79) 58.301 80) 66.518 81) 71.511
9.050	3.180	26.490	79) 11.509 80) 15.181 81) 27.102	79) 16.618 80) 17.153 81) 14.875	79) 10.833 80) 11.471 81) 12.278	79) 5.750 80) 9.915 81) 4.820	79) 44.710 80) 53.720 81) 59.075
6.731	3.132	33.260	79) 9.257 80) 13.763 81) 13.873	79) 9.599 80) 9.972 81) 10.061	79) 8.482 80) 9.189 81) 9.272	79) 17.192 80) 4.900 81) 4.944	79) 44.530 80) 37.824 81) 38.150
4.874	3.674	22.907	79) 8.952 80) 7.946 81) 8.210	79) 4.856 80) 5.310 81) 5.525	79) 5.551 80) 5.183 81) 6.416	79) 6.990 80) 11.141 81) 7.049	79) 26.349 80) 29.580 81) 27.200
17.011	2.682	81.286	79) 24.905 80) 33.235 81) 36.125	79) 36.125 80) 44.625 81) 51.595	79) 15.555 80) 15.555 81) 17.595	79) 4.165 80) 4.760 81) 2.975	79) 80.750 80) 98.175 81) 108.290

Continued on page 94

Table 2 World Plant Investment, Service Revenues and Construction Expenditures (continued)

excluding land and buildings ($ millions)

	Est. total telecom plant gross investment 12/31/79	Est. 1979 telephone service revenues	Actual 1978 construction	
			Inside plant	Outside plant
Telesat Canada	170.760	n/a		
Mexico, Telefonos de	409.270	752.440	n/a	n/a
Middle America				
Bahamas				
Bahamas Telecom Corp.	2.380	26.360	.004	.051
Grand Bahama Tel. Co. Ltd.	10.100	2.886	0	.037
Barbados Tel. Co. Ltd.	41.000	10.626	.419	1.252
Bermuda Tel. Co. Ltd.	28.875	13.406	.721	.510
Costa Rica	168.600	38.651	10.120	5.283
Dominican Republic	102.000	41.700	2.000	2.100
Puerto Rico Communications Authority	61.969	14.990	3.663	1.204
Virgin Islands (U.S.)	61.031	22.288	1.305	.347
South America				
Bolivian Assoc. of Tel. Cos.	124.142	n/a	n/a	
Brazil				
Cetel	12.745	30.780	22.112	12.800
Telamazon, Manaus	n/a	9.764	2.665	1.386
Telebahia	211.595	59.530	20.101	10.813
Telemig	320.000	154.111	56.116	6.946
Telepar	389.514	121.651	41.739	27.826
Telpa, Joao Pessoa	44.328	8.696	1.331	1.731
Chile	1,048.900[1]	110.900[1]	12.100[2]	12.400
Colombia				
Emcali	765.700	264.000	53.000	62.000

expenditures			Budgeted or estimated construction expenditures				
Station apparatus	Other	Total	Inside Plant	Outside Plant	Station apparatus	Other	Total
	47.984	47.984				79) 52.870 80) 62.985 81) 46.665	79) 52.870 80) 62.985 81) 46.665
n/a	n/a	2,405.800[17]					79) 323.700 80) 383.400 81) 504.800
.015	.013	.084	79) 4.917 80) 2.811 81) n/a	79) 1.620 80) .761 81) n/a	79) 1.216 80) 1.091 81) n/a	79) 2.158 80) .620 81) n/a	79) 9.910 80) 5.283 81) n/a
.022	.129	.188	79) .011 80) 1.352 81) n/a	79) .066 80) .142 81) n/a	79) .270 80) .621 81) n/a	79) .138 80) .183 81) n/a	79) .484 80) 2.297 81) n/a
1.271	.125	3.067	79) 2.670 80) 4.275 81) 3.000	79) .855 80) .584 81) 1.000	79) 1.271 80) 1.267 81) 1.460	79) .291 80) .390 81) .240	79) 5.087 80) 6.516 81) 5.700
1.266	.380	2.877	79) 1.480 80) 2.495 81) .775	79) 1.025 80) .650 81) .800	79) 1.660 80) .955 81) .985	79) .275 80) 1.575 81) 1.140	79) 4.440 80) 5.675 81) 3.700
.676	5.897	21.975	79) 7.000 80) 11.974 81) 28.974	79) 16.100 80) 13.073 81) 8.757	79) 3.000 80) 4.615 81) 7.228	79) 4.500 80) 4.602 81) 8.390	79) 30.600 80) 34.264 81) 53.349
4.000	1.000	6.100	79) 3.800 80) 8.600 81) 7.900	79) 3.000 80) 2.800 81) 5.300	79) 2.200 80) 2.900 81) 3.200	79) 1.900 80) 2.200 81) 2.500	79) 10.900 80) 16.500 81) 18.900
.376	1.551	6.794	79) 5.124 80) 15.594 81) 1.122	79) 8.641 80) 14.005 81) 3.781	79) 1.306 80) 3.400 81) 3.876	79) 1.868 80) 3.947 81) .820	79) 16.939 80) 36.946 81) 9.599
2.054	.290	3.996	79) .944 80) 1.247 81) 2.016	79) .723 80) 1.295 81) 1.054	79) 2.090 80) 1.981 81) 1.594	79) .344 80) .558 81) .456	79) 4.101 80) 5.081 81) 5.120
		n/a					79) n/a 80) n/a 81) n/a
1.411	2.818	39.141	79) 5.375 80) 6.334	79) 5.986 80) 10.656	79) .809 80) .305	79) .826 80) 4.233	79) 12.996 80) 21.527 81) n/a
.218	.524	4.792	79) 4.973 80) 5.668	79) .265 80) .634	79) .548 80) .271	79) .678 80) .190	79) 6.464 80) 6.763
.954	6.220	38.088	79) 11.616 80) 27.865 81) 8.275	79) 16.825 80) 19.644 81) 15.463	79) 2.033 80) 6.565 81) 6.937	79) 5.817 80) 11.609 81) 2.930	79) 36.290 80) 65.683 81) 33.605
1.504	14.544	79.110	79) 26.329 80) 28.348 81) 4.804	79) 13.671 80) 20.248 81) 8.992	79) 2.860 80) 4.278 81) 1.236	79) 11.084 80) 18.666 81) 13.178	79) 53.944 80) 71.540 81) 28.210
4.638	18.551	92.754	79) 29.705 80) 52.608 81) 49.472	79) 22.220 80) 28.345 81) 32.939	79) 2.778 80) 5.939 81) 7.204	79) 22.956 80) 20.491 81) 14.709	79) 77.659 80) 107.383 81) 104.324
0	.266	3.328	79) 4.817 80) 2.773 81) 4.529	79) 1.541 80) 4.921 81) 4.197	79) 0 80) 0 81) 0	79) .667 80) .535 81) 1.086	79) 7.025 80) 8.229 81) 9.875
9.800	2.800	37.100[2]	79) 21.900 80) 24.500 81) 27.500	79) 17.000 80) 31.800 81) 28.700	79) 8.700 80) 8.600 81) 12.700	79) 5.700 80) 18.300 81) 12.600	79) 53.300[1] 80) 83.200[1] 81) 81.500[1]
n/a	n/a	126.100	79) 22.000 80) 7.000 81) 9.000	79) 58.000 80) 114.000 81) 117.000	79) n/a 80) n/a 81) n/a	79) 28.000 80) n/a 81) n/a	79) 108.000 80) 121.000 81) 126.000

Continued on page 98

Table 2 World Plant Investment, Service Revenues and Construction Expenditures (continued)

excluding land and buildings ($ millions)

	Est. total telecom plant gross investment 12/31/79	Est. 1979 telephone service revenues	Actual 1978 construction Inside plant	Actual 1978 construction Outside plant
Empresas P. de Medellin	21.000	14.000	0	1.200
Ministry of Communications-Telecom	n/a	126.136	n/a	n/a
Peru (Peruana)	189.862	34.683	3.036	2.659
Europe				
Austria	2,434.828	1,021.719		
Denmark FKT. Odense	170.000	40.000	10.000	9.500
Jydsk Telefon, Arhus	540.000	194.000	27.400	37.200
Telefontilsynet, Copenhagen	1,750.000[3]	685.000	106.000	98.000
Finland National Assoc. of Private Telephone Cos.	333.000	241.000	44.000	35.500
Posts & Telecommunications Administration	642.000[4]	383.000		
Germany, Federal Republic of	4,408.000	13,224.000	n/a	n/a
Greece	1,429.767	463.211	51.882	24.027
Iceland	119.000	n/a	2.658	.858
Ireland	784.000	214.000	47.210	37.403
Malta	43.149	10.100	.551	1.378
Norway	449.800	649.700	190.635	117.668
Portugal	597.177	287.957	14.574	27.167
Spain	10,943.774	1,925.545	516.000	435.976
Sweden	4,001.300	1,545.500	26.800	64.600
Switzerland	8,429.000	1,729.000	205.000	188.000
United Kingdom	17,070.200[6]	6,674.100[6]	716.400[6]	437.800

expenditures			Budgeted or estimated construction expenditures				
Station apparatus	Other	Total	Inside Plant	Outside Plant	Station apparatus	Other	Total
1.200	.320	2.720	79) 3.000 80) 21.600 81) 16.600	79) 1.300 80) 7.500 81) 14.400	79) n/a 80) 260 81) 2.200	79) 4.000 80) 2.100 81) 4.300	79) 8.300 80) 31.460 81) 37.500
n/a	n/a	20.701					79) 59.314 80) 112.955 81) 156.463
1.331	.063	7.089	79) 10.740 80) 10.988 81) 1.413	79) 3.777 80) 7.844 81) 534	79) 3.943 80) 8.302 81) 0	79) 1.413 80) 4.911 81) .008	79) 19.873 80) 32.045 81) 1.956
		394.651					79) 445.539 80) 500.469 81) 518.344
4.700	6.100	30.300	79) 7.200 80) 6.600 81) 7.900	79) 8.700 80) 11.000 81) 9.800	79) 6.200 80) 6.200 81) 5.900	79) 4.200 80) 5.400 81) 3.900	79) 26.300 80) 29.200 81) 27.500
22.600	12.100	99.300	79) 33.000 80) 45.000 81) 38.400	79) 38.000 80) 41.500 81) 42.000	79) 23.300 80) 28.800 81) 29.200	79) 15.700 80) 21.000 81) 18.000	79) 110.000 80) 136.300 81) 127.600
64.000	14.000	282.000	79) 103.000 80) 83.000 81) 86.000	79) 80.000 80) 100.000 81) 82.000	79) 83.000 80) 84.000 81) 99.000	79) 59.000 80) 62.000 81) 54.000	79) 325.000 80) 329.000 81) 321.000
9.400	23.100	112.000	79) 48.300 80) 53.100 81) 58.200	79) 39.000 80) 42.800 81) 46.900	79) 10.300 80) 11.300 81) 12.400	79) 25.400 80) 27.800 81) 30.500	79) 123.000 80) 135.000 81) 148.000
		179.000					79) 186.000 80) 188.000 81) 183.000
153.120	n/a	2.813.000	79) n/a 80) n/a	79) n/a 80) n/a	79) 185.600 80) 229.100	79) n/a 80) n/a	79) 3.480.000 80) 4.060.000 81) n/a
18.216	16.681	110.806					79) 204.600 80) 312.803 81) 385.594
.494	2.190	6.199	79) 4.900	79) .750	79) .015	79) 900	79) 6.565 80) n/a[5] 81) n/a[5]
26.024	14.805	125.443					79) 161.000 80) 210.000 81) 269.000
.827	—	2.757	79) 4.180 80) 4.574 81) 7.220	79) 1.120 80) 2.589 81) 2.445	79) 406 80) 921 81) 978	79) — 80) — 81) —	79) 5.705 80) 8.083 81) 10.643
48.568	74.357	431.228	79) 207.323 80) 193.190 81) 169.120	79) 125.945 80) 130.235 81) 129.922	79) 49.535 80) 54.207 81) 59.687	79) 90.032 80) 83.366 81) 76.947	79) 472.835 80) 460.998 81) 435.675
16.311	19.902	77.954	79) 33.544	79) 52.840	79) 24.367	79) 72.101	79) 182.852 80) 229.288 81) 239.433
255.344	83.992	1,292.200	79) 496.206 80) 660.660 81) 792.792	79) 415.390 80) 545.045 81) 654.053	79) 256.911 80) 346.847 81) 416.216	79) 72.401 80) 99.099 81) 118.919	79) 1.240.908 80) 1.651.651 81) 1.981.980
73.800	109.100	274.300[6]					79) 364.000 80) 481.000 81) 594.000
15[illegible].000	—	544.000	79) 213.000 80) 208.000 81) 216.000	79) 176.000 80) 184.000 81) 191.000	79) 166.000 80) 162.000 81) 161.000	79) — 80) — 81) —	79) 555.000 80) 554.000 81) 568.000
437.800	398.000	1,990.000[9]	79) 696.500[8] 80) 875.600[10] 81) 1,094.500[14]	79) 537.300 80) 537.300 81) 577.100	79) 517.400 80) 557.200 81) 656.700	79) 417.900 80) 517.400 81) 557.200	79) 2,169.100[8] 80) 2.487.500[10] 81) 2.885.500[14]

Continued on page 100

Table 2 World Plant Investment, Service Revenues and Construction Expenditures (continued)

excluding land and buildings ($ millions)

	Est. total telecom plant gross investment 12/31/79	Est. 1979 telephone service revenues	Actual 1978 construction	
			Inside plant	Outside plant
Asia				
Bahrain	132.418	19.965	8.593	12.450
Brunei	31.795	3.540	.560	.563
China/Taiwan	1,279.543	439.777	107.536	91.010
Cyprus	21.098	23.100	3.563	1.632
Hong Kong	486.915	238.978	25.816	9.069
Israel	2,170.000	n/a		
Japan	n/a	15,154.000[8]	n/a	n/a
Kuwait	259.611	36.600	27.093	16.786
Nepal	6.894	3.140	197	.026
Philippines Philippine Long Distance Tel. Co.	397.000	100.000	25.000	10.000
Republic Tel. Co.	51.413[11]	4.744	2.945	1.815
Qatar	n/a	n/a	n/a	n/a
Telecom Singapore	412.090	124.310	16.390	36.040
Thailand	386.160	83.460	19.131	19.057
Africa				
Ethiopia	15.400	22.220		
South Africa, Republic of	1,870.121[9]	544.743	67.645	178.173
Zimbabwe Rhodesia	100.200	47.709[16]	4.660	4.400
Oceania				
Australia	10,264.000	2,200.000	216.700	313.700
Fiji	43.618	10.235	.577	1.174

expenditures			Budgeted or estimated construction expenditures				
Station apparatus	Other	Total	Inside Plant	Outside Plant	Station apparatus	Other	Total
2.790	27.230	51.063	79) 11.167	79) 10.058	79) 3.196	79) 29.531	79) 53.952
			80) 10.629	80) 7.944	80) 3.790	80) 21.533	80) 43.897
			81) 4.058	81) 7.324	81) 2.798	81) 16.366	81) 30.546
.280	.465	1.480	79) 6.136	79) 6.668	79) .685	79) 10.597	79) 24.086
			80) 2.409	80) 1.909	80) 1.136	80) 3.932	80) 9.386
			81) 2.636	81) 1.273	81) 1.591	81) 4.523	81) 10.023
13.939	74.627	287.112[7]	79) 113.509	79) 122.482	79) 20.463	79) 104.940	79) 361.394
			80) 151.390	80) 169.040	80) 27.824	80) 144.458	80) 492.712
			81) 216.921	81) 213.356	81) 32.135	81) 182.190	81) 644.602
1.755	.462	7.414	79) 11.404	79) 7.554	79) 2.230	79) 2.145	79) 23.335
			80) 10.928	80) 8.447	80) 3.855	80) 5.566	80) 28.800
			81) 11.200	81) 8.400	81) 2.800	81) 4.200	81) 26.600
6.585	6.678	48.148	79) 38.917	79) 12.991	79) 3.780	79) 13.505	79) 69.192
			80) 70.590	80) 10.123	80) 6.566	80) 30.247	80) 117.527
			81) 81.657	81) 10.631	81) 8.910	81) 38.445	81) 139.645
		n/a					79) n/a
							80) n/a
							81) n/a
n/a	n/a	7,846.000[9]					79) 7,742.000[8]
							80) 8.111.000[10]
							81) n/a
6.786	2.791	53.456	79) 20.806	79) 37.450	79) 7.693	79) 9.863	79) 75.811
							80) n/a
							81) n/a
0	.070	.293	79) 4.039	79) 1.544	79) .373	79) 1.909	79) 7.865
			80) 5.396	80) 1.292	80) .010	80) .617	80) 7.315
			81) 2.709	81) .858	81) 0	81) 1.093	81) 4.660
7.000	11.000	53.000	79) 45.000	79) 22.000	79) 10.000	79) 24.000	79) 101.000
			80) 45.000	80) 34.000	80) 16.000	80) 34.000	80) 129.000
			81) n/a	81) n/a	81) n/a	81) n/a	81) n/a
.315	.503	5.578	79) 8.709	79) 3.558	79) .783	79) .687	79) 13.737
			80) 3.453	80) 1.577	80) .718	80) .719	80) 6.467
			81) 2.138	81) .977	81) .455	81) .455	81) 4.005
n/a	n/a	n/a					79) 18.000
							80) 30.000
							81) 20.000
10.770	12.710	75.910[16]	79) 33.838	79) 19.883	79) 13.704	79) 13.074	79) 80.499[9]
			80) 45.630	80) 29.539	80) 15.970	80) 21.810	80) 112.949[8]
			81) 53.320	81) 35.290	81) 17.350	81) 22.120	81) 128.080[10]
0.889	9.300	48.377[12]	79) 36.044	79) 7.296	79) 4.484	79) 13.513	79) 61.337
			80) 68.012	80) 17.814	80) 5.500	80) 45.868	80) 137.194
			81) 93.862	81) 53.993	81) 9.091	81) 75.310	81) 232.256
		n/a					79) 2.568
							80) n/a
							81) n/a
29.075	1.079	275.972	79) 203.108	79) 72.579	79) 35.406	79) 2.789	79) 313.882
			80) 221.522	80) 93.527	80) 45.989	80) 2.437	80) 363.475
			81) 235.241	81) 84.421	81) 53.000	81) 2.680	81) 375.342
2.071	1.910	13.042[15]	79) 8.104	79) 3.972	79) 1.921	79) 2.010	79) 16.007
			80) 13.537	80) 5.128	80) 2.986	80) 2.179	80) 23.830
			81) 10.019	81) 5.334	81) 2.857	81) 2.137	81) 20.347
172.600	61.800	764.800	79) 230.000	79) 330.500	79) 199.100	79) 67.000	79) 829.600
			80) 249.200	80) 343.100	80) 221.400	80) 82.600	80) 896.300
			81) 257.500	81) 343.000	81) 235.600	81) 96.300	81) 932.400
1.380	1.312	4.442	79) 1.323	79) 2.792	79) .377	79) .130	79) 4.622
			80) 2.345	80) 2.386	80) .342	80) .188	80) 5.262
			81) 1.705	81) 1.895	81) .612	81) .196	81) 4.409

Continued on page 102

Table 2 World Plant Investment, Service Revenues and Construction Expenditures (continued)

excluding land and buildings ($ millions)

	Est. total telecom plant gross investment 12/31/79	Est. 1979 telephone service revenues	Actual 1978 construction	
			Inside plant	Outside plant
Guam	20.000	8.000	n/a	n/a
Mariana Islands	.500	.067	.050	.020
New Zealand	648.368	442.721[13]	19.770	16.440
Solomon Islands	n/a	.205		
Tonga	4.300	n/a	1.300	.700

Footnotes, Table 2

†not available

[1] Amount in U.S. $ millions, with exchange rate: 39 Chilean Pesos=US$1

[2] Amount in US $ millions, with exchange rate: 33.95 Chilean Pesos=US$1

[3] Book value

[4] Answers in Table 2 are for Finnish PTT only. For purposes of calculating world spending, TELEPHONY assumed PTT phones represented 25.22% of total Finnish phones (as in 1978).

[5] Not decided yet due to late parliamentary elections; most likely very similar to 1979

[6] July 1-June 30 financial year. In Sweden's case, 1977-78 and consecutive years thereafter

[7] Domestic telephone service only (also applies 1979-81)

[8] year ending 3/31/80

[9] year ending 3/31/79

[10] year ending 3/31/81

472,038,000 telephones.

Proceeding from these basic totals and the other information supplied by our respondents, we obtained the following Dec. 31, 1979 statistics.

Plant investment:

World non-U.S.	$197.042 billion
Bell System	120.321 billion
U.S. Independents	31.315 billion
World Total	$348.678 billion

Plant investment per station:

World non-U.S.	$663.44
Bell System	849.48
U.S. Independents	937.57
World Average	$738.67

Telecommunications revenues:

World non-U.S.	$86.651 billion
Bell System	45.050 billion
U.S. Independents	9.237 billion
World Total	$140.938 billion

Telecom revenues per station:

World non-U.S.	$291.75
Bell System	318.06
U.S. Independents	276.56
World Average	$298.57

In three years, that is, since the last time we made Investment and Revenue extrapolations, world non-U.S. plant investment has risen from $167.703 billion to $197.042 billion (TELEPHONY, Jan. 10, 1977); however, investment per station has actually dropped slightly from $669.47 at year-end 1976 to the above $663.44. (As our survey stands now, we ask for "Estimated Total Telecommunications Plant Gross Investment (excluding land and buildings), as of Dec. 31, 1979." We're realizing this does not sufficiently pinpoint the investment amount. Between now and next year's survey we'll be working with telecom industry advisers on a more exact definition.)

World (non-U.S.) operating revenues for '76 were $63.699 billion but for '79 were up to $86.651 billion. Revenues per station three years ago registered at $254.29 compared to the above $291.75. Inflation, of course, has been a big factor in the rise. How much is a highly complicated calculation, because so many nations are involved.

The top 15 construction spenders reporting to TELEPHONY outside the U.S. for 1980 are (in $ billions): Japan, 8.111; Germany, 4.06; United Kingdom, 2.488; Spain, 1.652; Bell Canada, 1.076; Australia, 0.896; Switzerland, 0.554; Austria, 0.500; Taiwan, 0.493; Sweden, 0.481; Norway, 0.461; Telefonos de Mexico, 0.383; Republic of South Africa, 0.363; Telefontilsynet (Denmark), 0.329; and Greece, 0.313.

Other countries we did not hear from, but which from past reports we could expect to be among the leaders, include (amounts again in $ billions): France, 5.498 (1979); Italy, SIP, 1.704 ('79); Netherlands, 0.391 ('78); Turkey, 0.388 ('79); and Telesp of Sao Paulo, Brazil, 0.339 ('79).

Then there is the $3 billion modernization project in Saudi Arabia on which the contract was signed in January 1978. The switching and related equipment part of the plan was to take three years; the operation and maintenance part, five years, and the whole was to

expenditures			Budgeted or estimated construction expenditures									
Station apparatus	Other	Total		Inside Plant		Outside Plant		Station apparatus		Other		Total
n/a	n/a	5.700	79) 80) 81)	2.500 1.600 .850	79) 80) 81)	10.000 3.400 6.700	79) 80) 81)	.200 .250 .225	79) 80) 81)	.300 1.350 .825	79) 80) 81)	13.000 6.600 8.600
.002	0	.072	79) 80) 81)	.030 .050 .050	79) 80) 81)	.020 .050 .050	79) 80) 81)	.006 .015 .015	79) 80) 81)	0 0 0	79) 80) 81)	.056 .115 .115
11.930	12.310	60.450[9]									79) 80) 81)	62.000[8] 62.000[10] 62.000[14]
		.200									79) 80) 81)	.374 n/a n/a
.015	.020	2.030	79) 80)	.200 .700	79) 80)	.400 .400	79) 80)	.100 .100	79) 80)	.150 .078	79) 80) 81)	.850 1.278 n/a

[11] As of 6/30/78
[12] Fiscal 1978, ending 9/30/78
[13] Total domestic and international telephone and record operating revenue for year ending 3/31/80. Includes est. domestic telephone service revenue (incl. inland toll revenue) of $361.047 (millions)
[14] Fiscal 1981, ending 3/31/82
[15] 6/30/79; following amounts for succeeding fiscal years
[16] year ending 3/31/78
[17] Total construction expenditures for all years up to 12/31/78

Exchange rates:
Bahamas: BH $1=US$1.0125
Finland: FIM 3.739=US$1
Spsin: Pts. 70.11=US$1 (1978 & 79)
Pts. 66.6=US$1 (1980 & 81)
Switzerland: SFr. 1.60=US$1
Taiwan: New T$36.00=US$1
Japan: Yen 209=US$1 (1978)
Yen 217=US$1 (1979-80)
Ethiopia: Birr 2.07=US$1

increase that country's telephone system from about 190,000 lines to 650,000 (TELEPHONY, Jan. 30, 1978).

A major enlargement of Indonesia's telephone network involves first the expenditure of $1 billion in the five-year plan concluded in 1979 to add 450,000 lines; then the addition of 500,000 more. (TELEPHONY, Oct. 22, 1979, p. 131).

From the foregoing Oct. 22 article comes a long-range Philippine spending forecast: private and government investment in telecoms is expected to total $340 million between 1978 and 1982, an amount likely to quadruple by 1987. Also, South Korea is investing $1.8 billion in communications between 1977 and 1982. In this latter country, Western Electric International, Inc., recently was selected to negotiate a five-year contract to provide nationwide electronic switching (TELEPHONY, Jan. 7, p. 13). WEI also would provide Korea with the technology needed to manufacture the switching gear in Korea.

Two other major contracts for te-

Continued on page 105

Table 3 Overseas Telephone Service*

	Two way messages			Two way messages	
	Quantity	Growth %		Quantity	Growth %
1927	11,753	—	1953	1,440,317	5.6
1928	22,665	92.8%	1954	1,529,152	6.2
1929	30,323	33.8	1955	1,742,368	13.9
1930	33,821	8.2	1956	2,024,117	16.2
1931	33,253	1.3	1957	2,421,332	19.6
1932	27,971	(15.9)	1958	2,687,836	11.0
1933	30,195	8.0	1959	3,088,645	14.9
1934	26,665	(11.7)	1960	3,713,183	20.2
1935	28,059	5.2	1961	4,365,020	17.6
1936	48,429	72.6	1962	4,914,262	12.6
1937	75,010	54.9	1963	5,290,460	7.7
1938	75,058	.1	1964	6,382,127	20.6
1939	76,189	1.5	1965	8,108,030	27.0
1940	73,429	(3.6)	1966	9,931,918	22.5
1941	116,680	58.9	1967	12,332,231	24.2
1942	135,196	15.9	1968	15,166,091	23.0
1943	153,799	13.8	1969	20,800,303	37.1
1944	173,799	12.8	1970	26,305,694	26.5
1945	360,341	107.8	1971	32,245,147	22.6
1946	631,665	75.3	1972	40,225,532	24.7
1947	664,273	5.2	1973	47,478,563	18.0
1948	797,531	20.1	1974	59,878,146	22.8
1949	852,864	6.9	1975	71,662,752	19.7
1950	1,000,184	17.3	1976	87,140,523	21.6
1951	1,263,362	26.3	1977	109,599,014	25.8
1952	1,363,775	7.9	1978	149,521,467	36.5
			1979	190,829,000	27.6E

*Overseas in this context is defined as all calls to and from the 48 contiguous United States to all points outside these states, except to Canada and Mexico

E=Estimated

Source: Business Research-Long Lines Department, Long Lines Statistics, (Bedminster: American Telephone & Telegraph, 1979) lecom expansion were announced during Telecom 79 in Geneva last September, the $1.8 billion five-year Egyptian transmission and switching contract awarded to Siemens of Germany, Thomson-CSF of France and Siemens of Austria; and the $500 million coaxial cable network contract award to an Italian consortium composed of Pirelli, Ceat, Telettra and SIRTI, by the Post & Telecommunications Corp. of Libya (TELEPHONY, Oct. 22, 1979, p. 65).

In this year's survey we asked for, and got, new kinds of information: Dec. 31, 1979 population estimates, which enable one to make up-to-date telephones per 100 of population estimates; number of households and businesses, which facilitate telecom density calculations in these two primary areas; and business and residence extensions for telephone user saturation ideas in these two sectors. Respondents were wonderfully helpful in these new respects as well as in furnishing again the extensive data requested in previous surveys. Were we to have made all the calculations possible based on old as well as new information, time to carry them out and space in this article would have been exceeded. (The column headed "Other," by the way, includes, for example, modems, housekeeping items, construction equipment, buildings, office equipment and furnishings, radio and remote switching terminals and concentrators.)

Once all this equipment is in place, how much is it used? One perspective on this question is the amount of international traffic originating and terminating in the 48 contiguous United States (see Table 3). In a word, the growth is phenomenal, and doesn't show any signs of leveling off. For the last three years, it has been climbing at better than 25% a year.

As we've seen, certain nations are going ahead with telecom expansion at an amazingly fast pace. Can they be thinking that telecom plant-invested money buys much more than just the equipment? As this writer sees it, it really does buy a communications capability that's going to keep these nations in the forefront of general technological advance, and contribute importantly to improving productivity country-wide. Up-to-date telecom equipment prepares a nation to deal with the information explosion, or the Information Age, as it's being called; enables it to furnish services for gathering and processing data plus the subsequent accessing capability. A PTT offering its customers the new sophisticated telecom devices is enabling them to compete more successfully in a world growing increasingly dependent on exporting. Such a country, too, is more ready to benefit domestically from all that telecommunications does to keep citizens, businesses and various other institutions in touch.

The world is well on its way to gaining these benefits—even though now, in early 1980, the progress is uneven. □

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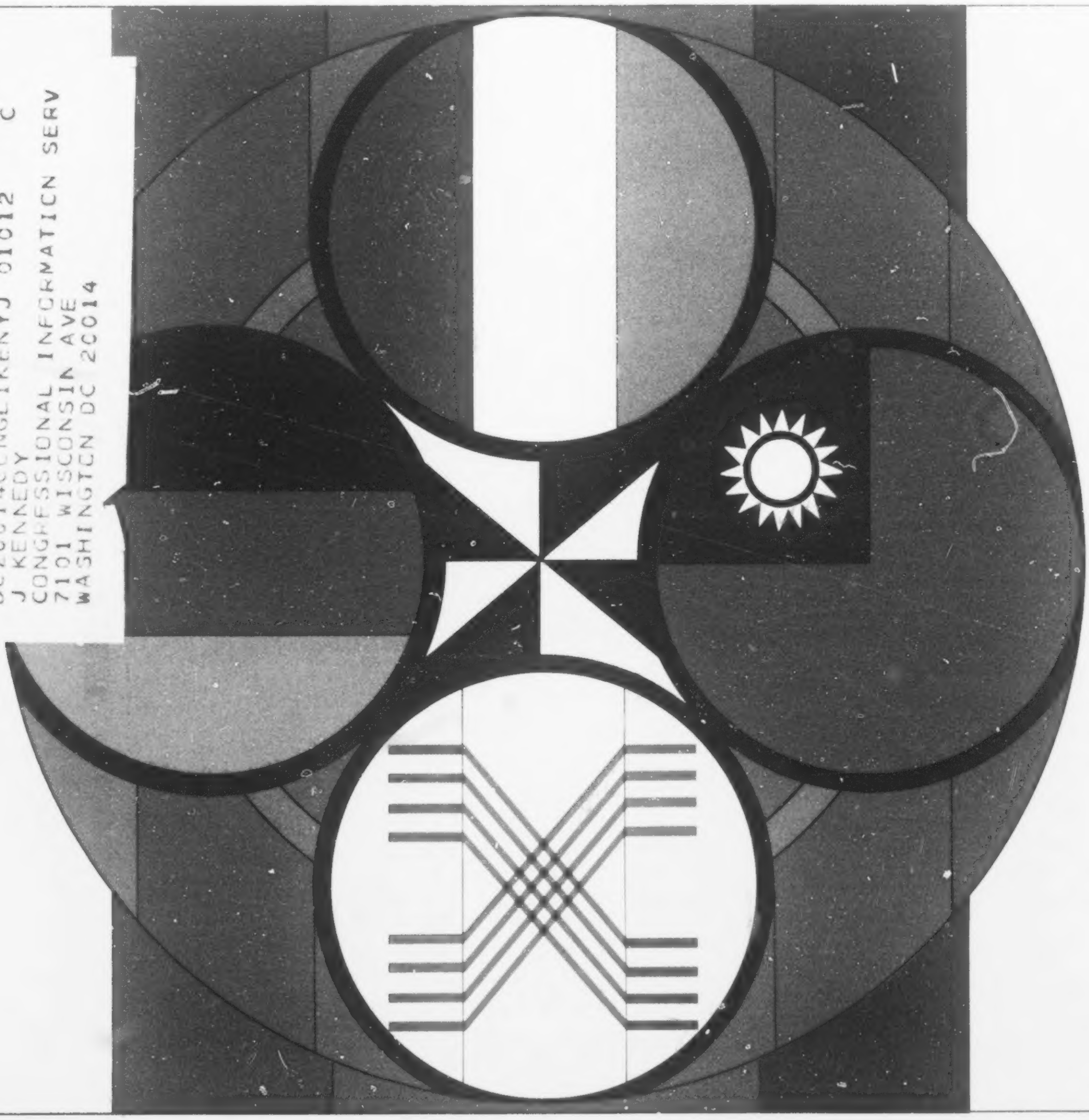

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T. C. CHIANG

Supplying the demand

During the past decade, the Taiwan Telecommunications Administration has had to cope with a 20% annual growth rate. Here, Managing Director T. C. Chiang discusses the continuing evolution in central office switching plant which is enabling the island community to keep up with demand

DURING THE 1970s the number of telephones in Taiwanese cities increased at the rate of 20% per year; this trend is expected to continue at only a slightly diminished pace during the 1980s. Electronic switching systems (ESSs), the ITT (International Telephone & Telegraph Corp., New York, N.Y.) Metaconta 10C and the GTE (General Telephone & Electronics Corp., Stamford, Conn.) No. 1 EAX are currently being introduced. By September 1979 eight ESS exchanges were in operation, accounting for 10% of the public service lines in Taiwan. This figure will rise to 26% by 1987. Fully digital switching systems are planned both for the toll network and for local exchanges. The majority of the ESS equipment is being manufactured in Taiwan, and local engineers are performing installation, operation and maintenance functions.

During the last decade, continuing economic prosperity and rising income levels due to Taiwan's rapid industrial and commercial development have caused ever increasing demand for telephone service. To meet this pressing demand, the Taiwan Telecommunications Administration (TTA) has made a maximum effort to increase telephone installations. As a result, the number of telephone subscribers in cities has increased from 182,788 in July 1969 to 1,689,724 in July 1979—an increase of 820%. The number of telephones has grown from 307,023 sets in 1969 to 2,341,469 sets in 1979—an increase of 660%. This sustained growth at a rate of more than 20% a year over a decade is indeed an unprecedented phenomenon. Tables 1 and 2 show the year-by-year growth in subscribers and telephones since 1969.

In 1976 the TTA initiated a six-year, medium range development plan. In order to meet the urgent and rising demand for telephone service, it has been necessary to revise upward the estimates for the last two years of the planning period (1980-1981). The target increases in new subscriber installations have now been set at 420,000 for fiscal 1980 and 620,000 for fiscal 1981. Therefore, at the end of the first six-year development plan the projected total number of subscribers and telephone sets will show 14.4 and 11.6 times increases respectively over the 1969 figures. By July 1981 the number of telephones per 100 persons in Taiwan is expected to reach 19.9. Table 3 shows the projected growth in number of subscribers for fiscal 1980 and 1981.

Table 4 shows the projected growth in number of telephones for fiscal 1980 and 1981.

Based on telephone statistics from 115 representative countries worldwide, a regression relationship can be established between telephone density and average per capita income. If Q represents the number of telephones per 100 persons and X represents the average per capita income in U.S. dollars, we have:

$$\log(Q) = 1.25 \log(X) - 3.27$$

The soundness of this regression relationship is borne out by the very high correlation coefficient of 0.91. Given that the average per capita income in Taiwan in 1977 was $1180, the regression equation yields a telephone density of 3.7 per 100 persons. However, the actual telephone density in Taiwan in 1977 was about 10, which far exceeds the number based on the worldwide regression relationship. This is a very unusual, but persistent, phenomenon.

In drawing up the preliminary plans for development during the second six-year period, 1982-1987, the Administration has considered a number of factors both internal and external to its operation. The internal factors include the Administration's financial and human resources, investment return rates, capabilities of suppliers, its role in guiding and assisting the development of local suppliers, and timing considerations. The external factors include Taiwan's economic growth rate and structure trends, income level and distribution, family size, subscriber behavior patterns, the characteristics of a matured telephone network that is approaching saturation, telephone installation and usage charges, and projected demand. In addition, the TTA has considered the relative role and impact of telecommunication development in the overall national economic development.

Our preliminary plans for the second six-year development period are based on the following assumptions: the number of subscribers will increase at an average annual rate of 16.4%, reaching a total of 8.6 million by 1987. Telephone density will reach 43.9 per 100 persons, or 0.81 per household.

Prior to 1969, almost all of the automatic exchanges installed in Taiwan were of the Strowger or Siemens Halskey step-by-step

Continued on page 106

T. C. Chiang is Managing Director of the Taiwan Telecommunications Administration. This article has been adapted from a presentation made at CommunicAsia held in Singapore last December type, procured from both local and foreign suppliers. Beginning in 1969, the Administration began to introduce C-400 electromechanical crossbar exchanges on a large scale. This undertaking was based on the policy decision to upgrade domestic telecommunication technology and to implement domestic direct subscriber toll dialing totally.

During the early days of our crossbar installation program, most of the material and equipment items were imported. But as the two local factories increased their manufacturing capabilities, we have within the last few years switched almost completely to local procurement of crossbar equipment. And as a result of the abundant demand, adequate supplies at economical cost, and the ample availability of Administration resources, we have achieved the phenomenal growth in the Taiwan network that was described earlier.

The next stage in the progress of switching technology was provided by the Administration's decision to introduce stored program controlled electronic switches into the Taiwan network. Since the successful trial of the first Bell System electronic switch in 1960, rapid and significant advances in electronic and computer technology have led administrations in most of the advanced countries to develop and adopt on an increasingly wide scale electronic switching systems that meet their needs.

We have all seen the development of the Bell electronic switching systems, the ITT Metaconta systems, the GTE EAX systems, the Japanese D10 and D20 systems, and many other European and American systems. Switching technology has improved from semielectronic matrix to fully electronic, from centralized stored program control to distributed control and from analog to digital switching. Although electronic digital switching is certainly the wave of the future, present digital systems seem to require additional development before they reach maturity.

Even though, due to our particular circumstances, electronic

Continued on page 108

Table 1

Fiscal Year	Increase in No. of Subscribers	Cumulative Total	Growth Rate(%)	Index
1969	33,168	182,788	22.2	100
1970	44,183	226,971	24.2	124.2
1971	51,721	278,692	22.8	152.5
1972	61,862	340,554	22.2	186.3
1973	87,125	427,679	25.6	233.9
1974	111,478	539,157	26.1	294.9
1975	146,975	686,132	27.3	375.4
1976	200,447	886,579	29.2	485.0
1977	205,870	1,092,449	23.2	597.7
1978	257,959	1,350,408	23.6	738.8
1979	339,316	1,689,724	25.1	924.4

TABLE 1 *Subscriber growth, 1969-1979.*

Table 2

Fiscal Year	Increase in No. of Telephones	Cumulative Total	Growth Rate(%)	Index
1969	52,407	307,023	20.58	100
1970	64,595	371,618	21.04	121
1971	71,373	442,991	19.21	144
1972	97,229	540,220	21.95	176
1973	122,526	662,746	22.68	216
1974	158,266	821,012	23.88	267
1975	189,016	1,010,028	23.02	329
1976	249,539	1,259,567	24.71	410
1977	284,152	1,543,719	22.56	503
1978	347,325	1,891,044	22.50	616
1979	450,425	2,341,469	23.82	763

TABLE 2 *Growth in number of telephones, 1969-1979.*

Table 3

Fiscal Year	Projected Increase in No. of Subscribers	Projected Cumulative Total	Growth Rate(%)
1980	420,000	2,109,724	24.9
1981	520,000	2,629,724	24.6

TABLE 3 *Projected increase in number of subscribers, 1980 and 1981.*

Table 4

Fiscal Year	Projected Increase in No. of Telephones	Projected Cumulative Total	Growth Rate(%)
1980	550,531	2,892,000	23.5
1981	679,000	3,571,000	23.5

TABLE 4 *Projected increase in number of telephones, 1980 and 1981.*

switching has not become competitively cost-effective or technically advantageous, we nevertheless decided to start adopting electronic switching because of its many operating and network advantages over electromechanical crossbar switches. Some of the advantages of electronic switching are its versatility and flexibility of operation, availability of new features, manageability of the network, ease and completeness of maintenance, and extended service life.

The energy- and space-saving advantages of electronic systems are not lost on us, particularly in today's environment where energy and urban land are becoming increasingly scarce. Continuing advances in electronic and computer technology should make electronic switching systems even more versatile and cost effective.

Finally, the introduction of electronic switching is also a way for the Administration to fulfill its objective of promoting the development of the domestic electronics industry. Our aims are to upgrade our technology, to computerize our operations and to modernize our management practices.

The Directorate General of Telecommunications (DGT) decided to adopt electronic switching as a way to catch up technically with the advanced countries, to respond to domestic economic development needs and to assist the development of a high-technology electronics industry. The vehicle through which electronic switching was to be introduced into Taiwan was the establishment of two joint-venture factories, based on agreements reached in 1973 with ITT and GTE.

The ITT-DGT joint venture, Taiwan International Standard Electronics Ltd. (TAISEL) started delivering ITT Metaconta IOC equipment late in 1976. The GTE-DGT joint venture, GTE Taiwan Telecommunications Ltd. (GTETTL) commenced delivery of GTE No. 1 EAX equipment in mid-1977. Presently, both factories have reached a production rate of 100,000 lines per year. By the end of 1979 TAISEL will start producing the Metaconta IOCN system; GTETTL is considering the introduction of its No. 2 EAX system late in 1980.

The original DGT agreements with ITT and GTE stipulated that, beginning in 1974, the Administration would place five yearly orders with TAISEL for a total of 370,000 lines of switching equipment, and five yearly orders with GTETTL for 280,000 lines of switching equipment. The delivery schedule is presented in Table 5.

The actual installation and cutovers of the equipment have been somewhat delayed due to a combination of procurement, implementation and site availability problems. The actual (1976-1980) and projected (1981-1982) cutover schedules of the 650,000 lines are presented in Table 6.

> 'Recent trends in the development of telecommunications technology and the information revolution clearly show . . .an integrated digital service network is a must for the future.'

As of the end of September 1979, eight electronic exchanges totaling 180,000 lines had been cut into service. Three more exchanges, totaling 80,000 lines, were to be cut over by year-end, bringing the total lines in service to 260,000. This accounts for about 10% of the total public service lines in Taiwan. By the end of the first six-year development period in June 1981, the total number of ESS lines in service is projected to reach 450,000 lines, about 12% of the total.

ESS switching procurement and installation as a percentage of total public lines are targeted to increase during our second six-year, medium range development period (1982-1987), based on preliminary plans. ESS lines are projected to account for 26% of the total by the end of fiscal 1987 (June 1987). The actual implementation of the plan will of course be influenced by such factors as stability of supply, relative prices, the Administration's own resources and changes in the general economy.

In order to assure the complete and correct transfer of ESS technology, the original DGT agreements with ITT and GTE specified local integration programs for TAISEL and GTETTL. Taiwanese engineers were sent overseas for training. In addition, the first orders were procured directly from GTE and ITT-BTM (Bell Telephone Manufacturing, Antwerp, Belgium), to insure on-time cutover and to provide the opportunity for hands-on installation and training activities by local personnel.

Starting with the second orders, deliveries were made from TAISEL and GTETTL with increasing local content. TAISEL's local manufacturing integration has reached approximately 80%, with all design work being performed by local engineers. Also starting with the second orders, the Administration began sharing the installation and test responsibilities in some of the non-turnkey exchanges.

The Administration has placed an order with Western Electric Co., New York, N.Y., U.S., for the turnkey supply of a Bell No. 4 ESS

Continued on page 110

Table 5

System	First Order	Second Order	Third Order	Fourth Order	Fifth Order	Total
No. 1 EAX	30,000	40,000	40,000	70,000	100,000	280,000
IOC	20,000	50,000	90,000	100,000	110,000	370,000
Total	50,000	90,000	130,000	170,000	210,000	650,000

TABLE 5 *Directorate General of Telecommunications/Taiwan Telecommunications Administration electronic switching systems procurement plan (number of lines).*

digital switch initially having 16,000 both-way trunks. Another order has been placed with ITT North Electric Co., Johnson City, Tenn., U.S., for 16,000 lines of ITT 1210 digital containerized local switching systems. The procurement of an additional 40,000 lines of digital containerized local switches is planned.

The decision to install the Bell No. 4 ESS digital toll switch was made after consideration of the rapidly expanding toll switching needs of the Taipei area (where there are already over 700,000 telephone subscribers), the inadequacy of the traditional C-82 crossbar toll switch, the maturity of digital toll switching technology and the relative ease of starting digitalization at the toll level. The No. 4 ESS switch is scheduled for cutover in the Taipei area in June 1981.

Our purchase of the ITT 1210 digital containerized exchanges was based on two separate considerations. The need for trailer exchanges was not new; we had been installing crossbar trailer exchanges in locations where either a permanent site was not available, or the installation of conventional equipment was impractical. The decision to purchase some digital trailer exchanges was prompted by our realization that despite the fact that large digital local switching systems are not yet mature, the future definitely belongs to digital switching. We therefore decided to purchase the 4000-line digital trailer switches both to meet our urgent demand, and to give ourselves the opportunity to investigate in depth the technology and operation of digital switching. The four ITT 1210 digital trailer switches are to be put into service by the end of 1980. Although we do plan to import 10 additional 4000-line digital trailer exchanges, our long-term planning calls for the development of local supply on a large scale.

The initial installed costs of stored program controlled electronic switches started out at about twice the installed cost of crossbar exchanges. This additional cost placed an extra burden on TTA's financial resources. But because electronic switching systems have made up a relatively minor percentage of our total installation, the extra burden has not been too difficult to bear. However, as we plan for increasingly larger percentages of ESS installations, the relative cost-effectiveness of ESS and crossbar must converge, so that the extra burden is gradually reduced. This can be brought about only by a reduction in the cost of ESS equipment. Relative costs and Administration resources also will be important considerations when we come to make the digital local switching decision.

As regards human resources, TTA sent 40 engineers to ITT-BTM and GTE for training during the early days of the introduction of Metaconta IOC and No. 1 EAX. After completing their training, these engineers participated in on-site installation and testing activities. Furthermore, they joined our Telecommunication Training Institute training programs in order to assist in the training of other TTA personnel. Today we are confident that TTA can adequately operate and maintain our ESS exchanges.

Because of their versatility and flexibility, electronic exchanges can very economically provide a number of operational facilities for the Administration and service features for the subscriber. In Taiwan, we have made the following new service features available:

- *Direct international dialing.* As of Nov. 1, 1979, we had already opened direct international dialing between Taipei and the U.S. mainland, Hawaii, Japan, Hong Kong, Singapore, Australia, Canada, Italy, Switzerland and Spain. We will provide direct international dialing to other countries from additional points within Taiwan.
- *Local automatic message accounting.* This not only provides more accurate records, but also improves responses to subscriber inquiries, thereby avoiding unnecessary confusion.
- *Abbreviated dialing.*
- *Call waiting.*

There are several other service features available from ESS exchanges which have not yet been offered to our subscribers. These include call forwarding, three-way calling, conference calls, wake-up service, do-not-disturb service, hot line and Centrex CO (central office).

One of the important considerations in our original decision to bring electronic switching to Taiwan by establishing local factories was to promote and stimulate the development of a technology-intensive electronics industry. This has proven to be a very sound decision as more and more of the components used in ESS equipment have become available from local suppliers.

Also, the high quality required of ESS equipment has served to improve the quality standards at some of our local manufacturers of electronic components. The need for software design in ESS equipment has provided a good training ground for the development of our software capabilities.

Recent trends in the development of telecommunication technology and the information revolution clearly show that the establishment of an integrated digital service network is a must for the future. We have already started to digitalize our transmission medium, through large scale placement of PCM (pulse code modulation) transmission equipment. Digital switching, both at the toll and the local level, also is included

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Table 6

System	1976	1977	1978	1979	1980	1981	1982	Total
No. 1 EAX	20,000	10,000	—	80,000	40,000	90,000	40,000	280,000
IOC	—	20,000	50,000	80,000	70,000	100,000	50,000	370,000
Total	20,000	30,000	50,000	160,000	110,000	190,000	90,000	650,000

TABLE 6 *Actual (1976-1980) and projected cutover schedules for electronic switches (no. of lines).*

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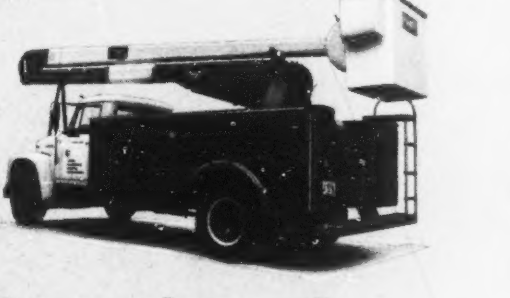

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in our telecom plans.

We have started to digitalize our toll switching operations, but the present status of digital local switching does not permit us to begin adopting it. In the meantime, because of the pressing demand in our society for telephone services, we must continue to install analog switches on an increasingly larger scale, until digital local switching becomes practical. Before long, it will become necessary to plan the integration of the digital equipment into the analog network. The implementation and operation of this hybrid analog digital network will require careful and constant attention on the part of our Administration.

Based on my personal experience and reflection, I believe that a number of important factors must be carefully considered and evaluated before a developing country or region decides to introduce electronic switching technology. These are:

1) The high initial cost in the early days of ESS introduction, and its impact on the administration, must be carefully evaluated and planned for.

2) Very high initial installation charges to subscribers constitute a major source of funds for the administration in a developing region. These funds, however, must be used for capital investment purposes, and not treated as operating income.

3) A comprehensive long-term investment plan is a cornerstone of the introduction of ESS technology. The administration must take the initiative in formulating the method and timing of the introduction of the technology.

4) Administration personnel must participate fully in the introduction of electronic switching, regardless of the type and time.

5) A prerequisite to the introduction of ESS technology is the upgrading of the skills of technical personnel within the administration. In particular, the training of software personnel is of vital importance. A telephone administration must ensure that software capability already exists, or will be introduced, as a part of any plan to introduce electronic switching. □

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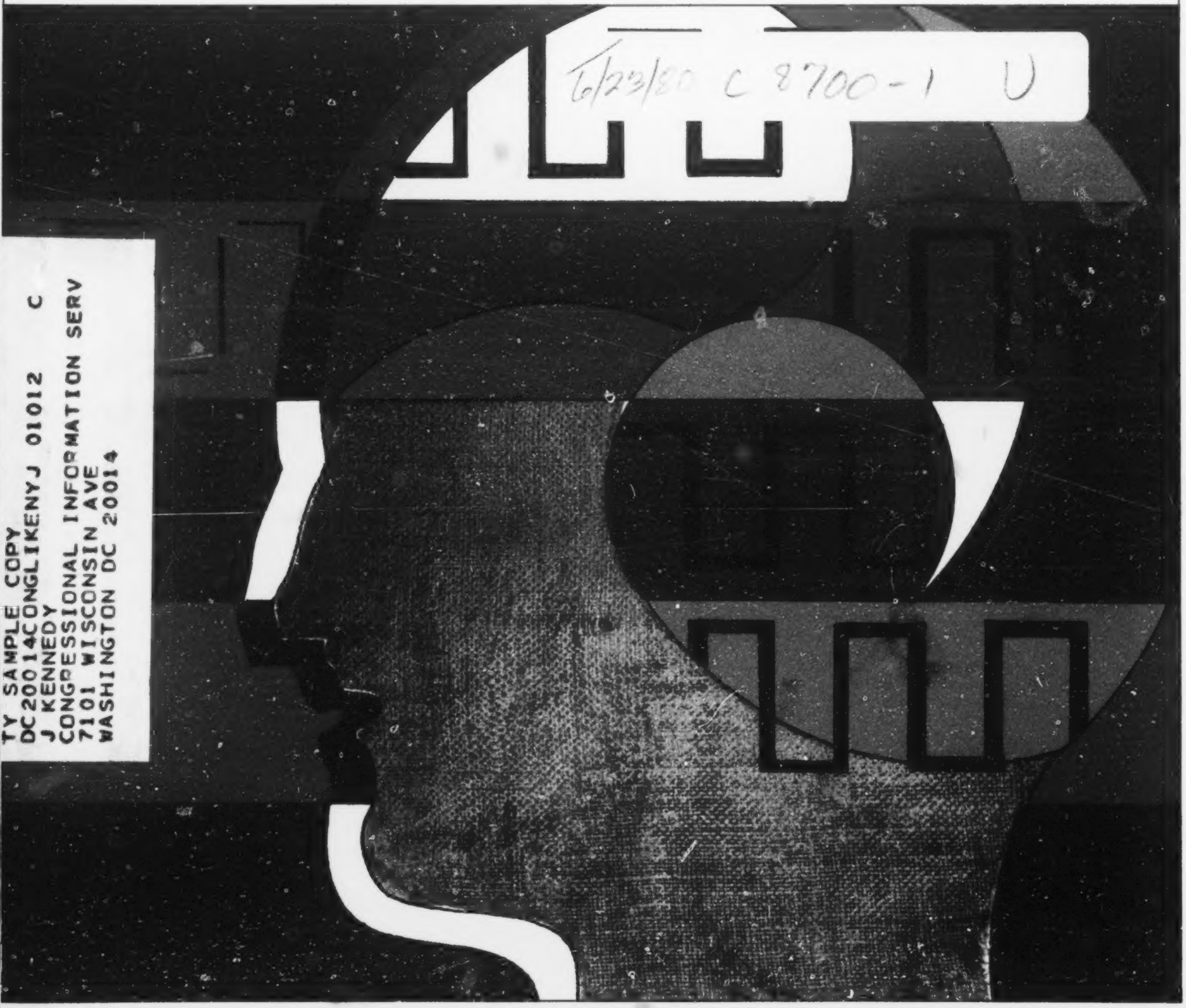

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Continental Telephone's digital experience

With 100 digital COs in place, Continental sees fewer troubles, but things still could be better

The extensive digital experience of Continental Telephone Corp. is explored in this two-part article. Part 1, which begins on these pages, covers implementation progress, the influence of digital on network design, and hardware considerations and experience. Part 2, which will appear in an early issue of TELEPHONY, *will cover software considerations and experience, network considerations and experience, future requirements and an overall assessment of the company's experience to date.–Ed.*

B.M. BARBE, R.G. DeWITT and R.L. SKELTON

A GENERALLY accepted definition of "digital switching" is the transmission of digital signals through a switch in which the signal path is established by either space division or time division. In this article the terms *digital switching* and *digital switch* will be used in place of *time division digital switching* and *time division digital switch*, respectively.

In 1970, the world's first digital switch was placed in telephone service in Lannion, Brittany, France. In January 1976, the Bell System's first No. 4 ESS (electronic switching system) in Chicago was the first digital switch in service in the United States. Three months later Continental Telephone became the first Independent telephone company with a digital switch in service. It was a TRW Vidar IMA-2 in Ridgecrest, Cal. Thus, Continental Telephone was an early supporter of digital switching and remains committed to that technology.

The advantages of digital switching in conjunction with digital transmission no longer are debatable. Briefly stated, they are:

Lower cost;

Less space required;

Provides the opportunity to integrate services;

Digital trunks eliminate channel banks for additional savings;

Trunk maintenance on a group basis;

Remote switch concept achieves additional savings by having the administration and maintenance capabilities at the host switch;

New services bringing additional revenue can be added more easily with less cost;

Remote switches in the subscriber plant reduce costs of the feeder cables.

A goal that is realizable during

ALL THREE authors are with Continental Telephone Service Corp. BRUCE M. BARBE is Director-Network Planning, Merrifield, Va.; RUSSELL G. DeWITT is Director-Technology Assessment, Merrifield, Va., and RONALD L. SKELTON is Director-Network Design, Atlanta, Ga.

Table 1

Class 4

TRW Vidar ITS 4

Northern Telecom DMS 200

Class 5

TRW Vidar ITS 5 & 4/5

Northern Telecom DMS 10

Stromberg-Carlson DCO

NEC America NEAX61

Table 2
Number of digital switches in service and on order by office class as of year-end 1979

Office class	In service	On order	Total
4	14	2	16
4/5	5	16	21
5 Host	59	61	120
5 Remote	15	80	95
Totals	93	159	252

the decade of the '80s is the Integrated Services Digital Network (ISDN) on which voice, enhanced voice, and all conceivable nonvoice services except broadcast television will share common switching and transmission facilities and do it in a cost-effective way. In the past it was necessary to build separate networks for different services because analog transmission and switching did not provide the flexibility required to do otherwise. Now that the rapid spread of digital transmission and digital switching is a reality, the opportunity to provide a common network finally exists.

Implementation progress

As shown in Figure 1, Continental Telephone has about 1800 local office (class 5) switches and about 100 toll office (class 4) switches. Prior to 1976, these switches were predominantly electromechanical. Thus, the opportunity to skip the electronic analog switching stage of evolution and go directly to digital switching was presented. Studies showed that it would be cost-effective to do this in the latter part of the '70s and that the savings would be even greater in the '80s as the percentage of direct digital terminations grew. Also, the ability to offer new services possible only with an all-digital network would be a bonus sometime in the future.

Table 1 shows the different types of digital switches currently in service; Table 2 shows the number of digital switches in service and on order by class as of year-end 1979. The total of 93 in service (now there are more than 100) is the largest number for any single carrier in North America. By the end of 1981, 37, or 37%, of the class 4 switches will be digital. At the same time, 236, or 13%, of the local switches will be digital. Table 3 shows the breakdown of the switches in service by manufacturer. At the end of 1979, Continental Telephone accounted for approximately one-third of the U.S. total for three of the four suppliers shown. The approximate U.S. totals for these four suppliers at the end of 1979 are shown in Table 4.

While the number of digital switches in service is growing, so, too, is the amount of digital transmission. More than 50% of Continental Telephone's trunks are on digital

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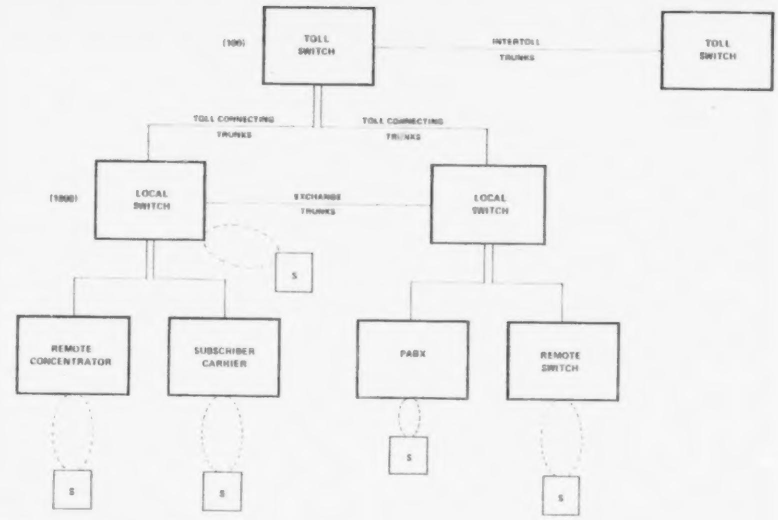

FIG. 1 *Network block diagram.*

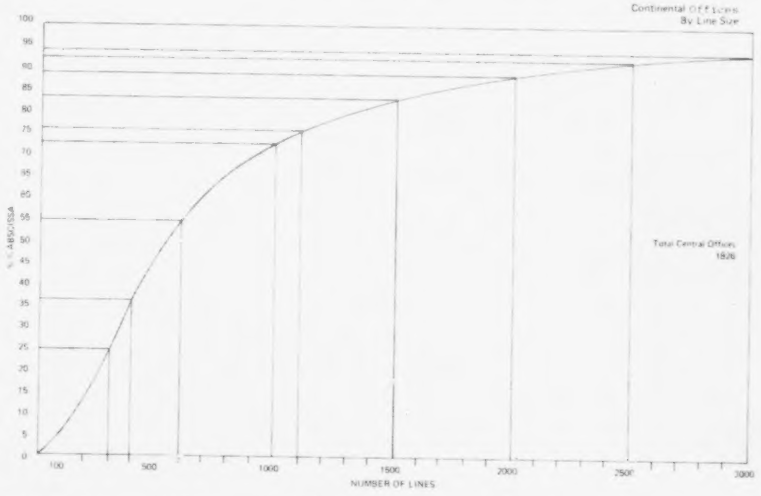

FIG. 2 *Cumulative distribution for Continental office sizes.*

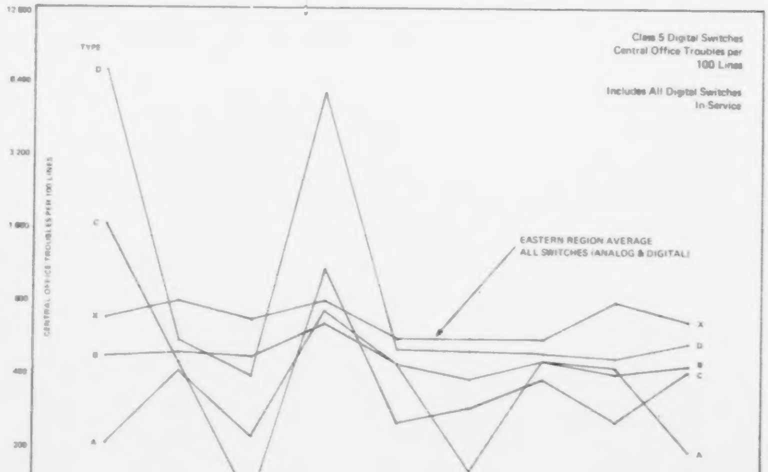

FIG. 3 *Class 5 switches, CO troubles per 100 lines.*

Table 3
Number of CTC digital switches in service as of year-end 1979

	Offices	Percent of U.S. total	Remotes
Northern Telecom	38	32.5	
TRW Vidar	30	37.0/33.3	15
Stromberg-Carlson	6	9.5	
Nippon Electric	4	36.4	
Total	78	28.7	

Table 4
Number of digital switches in service as of year-end 1979

	Offices	Lines	Remotes
Northern Telecom	117	170,000	0
TRW Vidar	81	54,000	45
Stromberg-Carlson	63	94,000	0
Nippon Electric	11	40,000	0
Total	272		45

transmission facilities which include T1 carrier on copper cables, digital microwave radio and digital transmission on optical fiber cables. About 5000 PCM (pulse code modulation) channel banks have been installed. It is interesting to note that as the digital network becomes more integrated, a point will be reached at which new PCM channel banks will not be required because reuse of displaced channel banks will satisfy growth requirements.

This may begin to occur in about two or three years from now.

Network design

Figure 2 is a plot of the cumulative distribution for Continental Telephone office sizes in terms of total lines. It shows that 72.4% of the offices have 1000 lines or fewer, 88.7% of the offices have 2000 lines or fewer, and 94.2% have 3000 lines or fewer. Thus a 3000-line switch would satisfy most of the needs if the old concept of separate, independent offices was retained. However, the digital approach made possible a new concept of remote switches slaved to host switches, centralizing most of the intelligence and maintenance. This is more cost-effective today. Another name for this concept is *distributed switching.*

History has a way of repeating itself. At one time, computer users were trending toward centralized large mainframes, then when the minicomputer and microprocessor appeared with lower unit cost, the pendulum swung in favor of distributed computing. There is a trend toward distributed switching now for similar reasons. Therefore, a host switch is needed that will accommodate an aggregate of at least 12,000 lines made up of host lines plus the lines terminated on a number of remote switches which can accommodate up to 1000 lines each. Such a remote switch size will accommodate almost three-quarters of the offices. Offices with more than 1000 lines are likely host switch candidates.

Some of the remote switches will be placed in the feeder cable plant to avoid the cost of new feeder cable. Also, digital subscriber carrier with a direct digital interface with the remote switches will be used to effect additional savings by extending further out to low density rural areas. The goal is to establish digital islands in various parts of the network. A "digital island" is defined as an area in which two or more digital switches, which may include one or more remote switches, are interconnected by digital trunks on copper, glass or microwave radio of either the terrestrial or satellite variety. Each year as additional construction is completed, these islands grow a little larger. Eventually these islands will start to meet either by physically running into each other or by means of long haul digital connectivity and form still bigger islands. This process will not end until the core network is digital across the entire country, approximately in 1995. Another aspect of a digital island is network synchronization; the switches in a digital island all are synchronized to the same clock.

Two strategies were available for the introduction of digital switching into the network: one was to co-locate digital switches with the electromechanical switches; the second approach was to replace the electromechanical switches and reuse the removed equipment in other electromechanical offices. This eliminates the need to purchase additional equipment that is rapidly rising in cost because of the high production labor content and the falling production quantity. It was very clear that the latter course was best. As a result an extensive replacement and reuse program has been underway. During 1980 approximately 80% of the analog switching equipment requirements will be met through the Reuse Program. This approach also has been called *mature system containment* in some circles.

As previously discussed, savings can be realized by the consolidation of numbers of central offices in host-remote configurations. Recognizing that about 40% of the construction budget is spent on outside plant, further steps can be taken to realize additional savings in the subscriber cable plant. By using remote switches in the feeder cable plant instead of adding more physical cable, considerable savings can be attained.

Recent network studies on exchanges in Pennsylvania and North Carolina show the typical savings that can and are being realized. In three exchanges in Pennsylvania, a first cost savings of about $900,000 is being attained by the use of nine remote switches. In North Carolina the first cost savings in 14 exchanges will be about $2.8 million.

In order to achieve these savings, suitable host-remote switch architecture and packaging must be available. Only one manufacturer has a remote switch designed and packaged for outside plant use; only one other manufacturer has immediate plans to provide this type of packaging. Most applications in the subscriber outside plant can be satisfied by a remote switch which will serve approximately 500 lines and is housed in a one- or two-cabinet configuration. However, in some localities there is resistance to a cabinetized remote switch. This resistance increases if the remote units are housed in a hut or trailer. Unfortunately, no manufacturer has stepped forward with a solution to the problem. One possible solution would be to place the unit underground. This would solve problems of esthetics, security and perhaps even the need to purchase or lease land.

Hard look at hardware

There are many different aspects of digital switch architecture that must be considered in any comparison. Among them are: byte or bit switching, digital or analog concentrators, type of switching network (TST or STS or other), nonblocking versus some blocking in the non-concentrating portion of the switching network, availability of a remote switch with a housing suitable for outside plant use, stand-alone capability of the remote switch, processor capability in terms of busy-hour call attempts that can be handled, system size in terms of number of terminations including lines, trunks and service circuits, call-carrying capacity in erlangs or CCS, memory for call store and data store, overload behavior, the codec arrangement is per-line or common to N lines, internal bit rates, environmental limits, power required, physical size.

When selecting a digital switch it is vitally important to be aware of design limitations that later can cause operating difficulties or problems in absorbing growth and feature additions. For example, it was discovered that with one type of digital switch the maximum number of terminations is reduced drastically when custom calling features are added. This can cause the exhaust point to be reached much earlier than planned. This same switch also caused RF radiation from subscriber cables at one location and went down completely at another location when a door was opened, letting in cold outside air.

Table 1 shows the different types of switches currently in service. With regard to the above list of architecture options, each version of the first four items is employed in at least one type of digital switch. For example, the DMS-10 and DCO use bit switching, whereas all the others use byte switching. The NEAX-61 uses an analog concentrator, while the others use digital concentra-

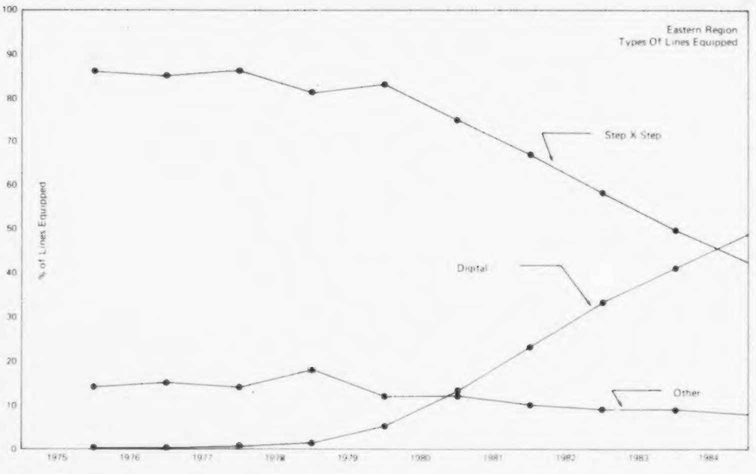

FIG. 4 *Eastern Region, types of lines equipped.*

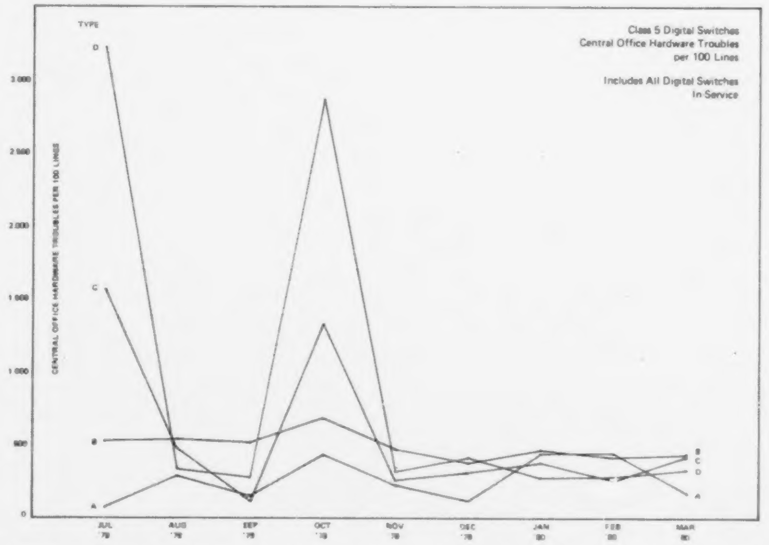

FIG. 5 *Class 5 digital switches, CO hardware troubles per 100 lines.*

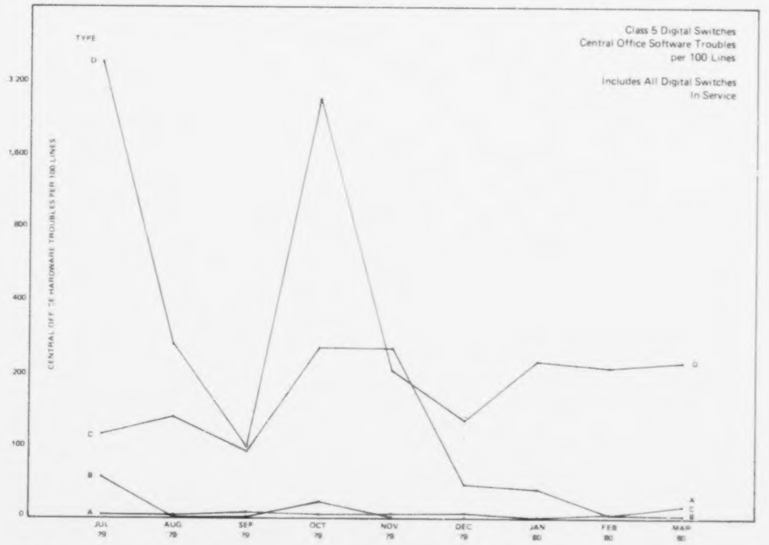

FIG. 6 *Class 5 switches, CO software troubles.*

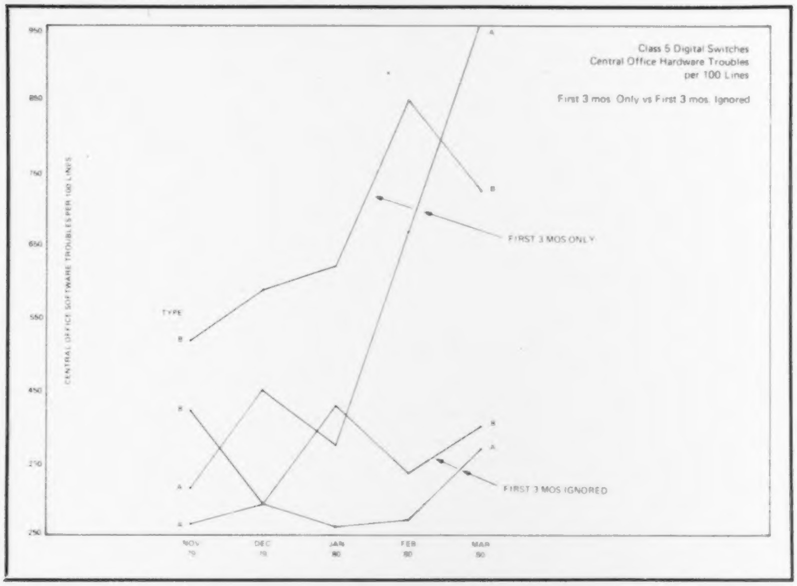

FIG. 7 *Class 5 switches, CO hardware troubles.*

tors. Although Stromberg-Carlson employs an analog concentrator in some configurations of its switch, it is not used in the Continental Telephone applications. The switching network for the ITS 5 uses STS, whereas all the others use TST. The ITS 5 is non-blocking in the non-concentrating portion of the switching network, and all the others have some blocking. The DMS 10, DMS 200 and DCO use per-line codecs, while the others use shared codecs. With regard to the other items in the list it can only be said that a given switch should have sufficient terminations, call-carrying capacity, processor capability, and memory to satisfy the intended application for the desired length of time.

A few other comments are appropriate. Bit switching is more compatible with incoming serial digital data signals but less compatible with incoming byte organized PCM lines. Analog concentrators will not be satisfactory in the long run when digital subscriber loops are employed. It is relatively inexpensive for the non-concentrating portions of TDM switching systems to be made non-blocking. For trunk switching this provides the following benefits:

- Rearrangements are not required;
- Nailed up connections will not cause blocking for other traffic;
- Multi-slot connections will not cause blocking for other traffic.

There is a digital switch design issue that has to do with integral versus external capabilities. Users naturally would like to have the switch do everything—loop plant

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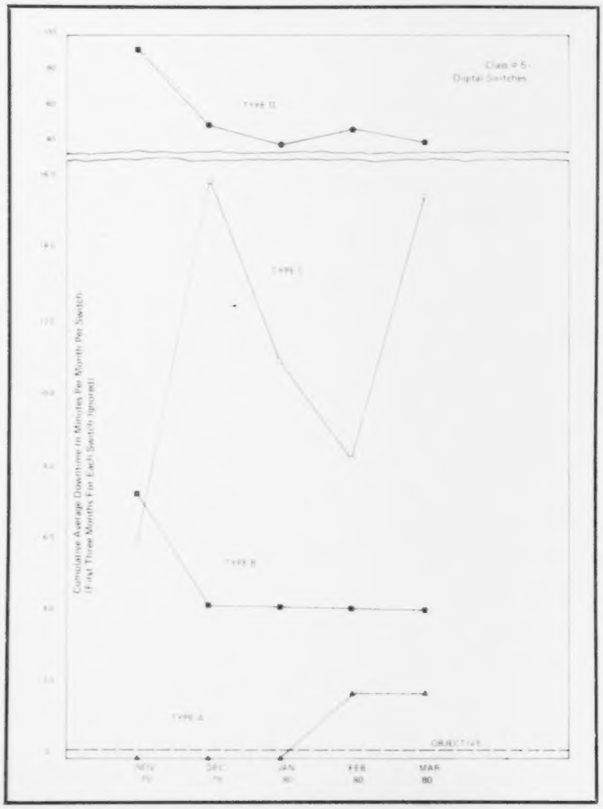

FIG. 8 *Class 5 digital switches, average downtime.*

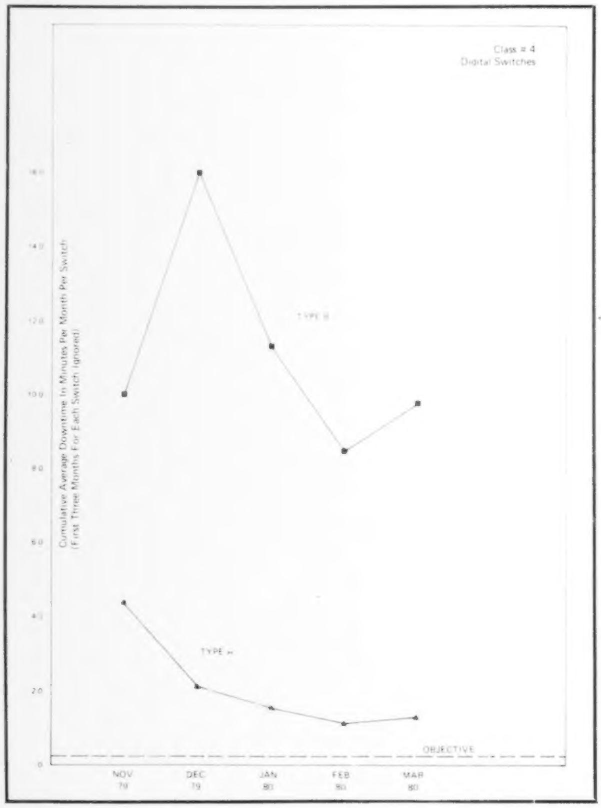

FIG. 9 *Class 4 digital switches, average downtime.*

monitoring and testing, trunk monitoring and testing, data collection, data processing and remote transmission. Manufacturers probably feel that they are being pressed to do too much too fast and that it may not be cost-effective to make all of these additional functions integral with the switch rather than external. Clearly, more processing power, more memory and more software are required, and there are costs associated with all these. More tradeoff studies are needed to ascertain the optimum division between integral and external functions. However, as time goes by it is probable that more integration will be cost-effective as a result of the rapidly inflating cost of labor incurred with separate, less automated systems.

Performance standards

Some measures of performance for a digital switch include the following:

- Error rate: 1x10^9 or better at 64Kbps;
- Slips: 1 in 70 days or better at 64Kbps;
- Transmission delay;
- Jitter and wander;
- Grade of service: blocking probability, 1x10^{-3} or better, probability of delay;
- Switching delay: call set-up time;
- Probability of premature release of a connection;
- Probability of incorrect charging;
- Frequency of loss of framing;
- Circuit quality.

A great deal of work is being done by CCITT (International Consultative Committee on Telegraph & Telephone) study groups to specify requirements for each item on the above list. A few tentative proposed numbers are shown above to illustrate that firm numbers will be forthcoming for these and other performance criteria.

Tracking trouble

A series of graphs accompanying this article illustrate the experience thus far with digital switching troubles. Figure 3 represents the monthly comparison of four types of digital switches from July 1979 through March 1980. Central office troubles per 100 lines per month is represented with Continental's Eastern Region's overall average provided as a comparison. As shown in Figure 4, this overall average is dominated by the large percentage of step-by-step switches that remain. However, it can be seen that for one of the three Continental Telephone regions which is typical of the others almost 50% of the lines will be on digital switches by 1984. Two observations can be made with respect to Figure 3: first, there seems to be an overall settling down of troubles attributable to the digital switches; and second, after settling, the troubles attributable to all four types of digital switches are below the Eastern Region average, which indicates that digital switching has fewer maintenance problems.

The second and third graphs in this series provide a more in-depth analysis of the first graph. Figure 5 shows the amount of the central office troubles attributable to hardware problems, and Figure 6 indicates troubles related to software.

Both graphs indicate a recent lessening of troubles. It is obvious that major hardware problems are being overcome by the manufacturers, but that improvement still is needed. The existing software generics for one manufacturer's switch have maintained the objective of zero troubles per 100 lines per month over the last five months. The other types of switches continue to have some software problems.

Hardware and time

Figure 5 shows the decrease in total hardware problems as a function of time. In Figure 7 the hardware troubles are segregated into two categories: first, troubles encountered in the first three months of a switch's life; and second, troubles encountered during and after the fourth month. For simplicity, the data is graphed on only two types of switches. It can be seen from this graph that after a three-month period, the troubles per 100 lines per month decreased considerably for both types. It also is apparent that the number of hardware problems encountered in the first three months is considerably higher than an acceptable level and even after the first three months the switches still are encountering more hardware problems than the objective. The objectives that have been established

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are 0.2 trouble per 100 lines per month for hardware and zero troubles per 100 lines per month for software. None of the four manufacturers is meeting the first objective as yet, and only one manufacturer appears to be meeting the second at this point.

Availability

With respect to availability, the best measure is downtime in which the switch is completely out of service.

The long established objective for downtime is one hour in 20 years. This is equal to an average of three minutes per year, or an average of one-quarter of a minute per month. Negligible downtime probably is the most important factor contributing to customer satisfaction. Figure 8 shows the downtime experience accumulated to date for class 5 digital switches. In order to give each manufacturer a reasonable opportunity to shake down early problems, downtime for the first three months for each switch has been excluded. For each month the total downtime for the current population of each type of switch is divided by the population number to get the average downtime in minutes per month per switch for that category.

Monitoring

Then these monthly averages are used to get a cumulative average in which all the monthly averages up to the current month are added and the sum divided by the number of months accumulated since the November 1979 start. The objective is shown as a dotted line at a cumulative average of 0.25 minute per month per switch. A well-behaved switch will approach the objective in a reasonable amount of time in an exponential or damped oscillatory manner. It can be seen that the four types differ widely in their behavior. Only type A is within reasonable distance of the objective at the present time. Likewise, Figure 9 shows that the two types of class 4 digital switches show significantly different behavior patterns. Type A shows a very nice classical exponential approach to the objective.

There is no substitute for this type of continuous monitoring of performance to make sure that objectives are being met. □

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which are simultaneously.

Relating phase shift to envelope delay. Amplitude modulating a low frequency sine wave (f_m) onto a carrier frequency (f_c) produces an amplitude modulated (AM) signal as shown by waveforms (a), (b) and (c) in Figure 5. The envelope of the AM signal is the outline of the peak excursions of the modulated signal as shown in waveform (d) of Figure 5. The AM process produces a signal whose frequency spectrum consists of the carrier frequency plus an upper sideband ($f_c + f_m$) and a lower sideband ($f_c - f_m$). Figure 6 illustrates this relationship. Because the upper sideband is of a higher frequency than the carrier, it undergoes a greater phase shift than the carrier; because the lower sideband is of a lower frequency, it undergoes less phase shift.

If the AM signal is transmitted over a circuit, the phase shift difference between the lower and upper sidebands causes the modulation envelope to experience a phase shift (or a delay). With a constant f_m the frequency difference between the sidebands is constant regardless of f_c. If there is no phase distortion, that is, phase shift is linear with frequency, the delay for a constant f_m also will be constant as f_c is changed. (See Figure 7A and 7B.) With phase distortion the envelope delay-versus f_c curve will look more like Figure 7D.

The measurement technique is based on measuring envelope delay as f_c is varied across the line's bandwidth. As shown in Figure 8 one test instrument transmits an AM signal, the receive instrument saves the envelope information and uses it to amplitude modulate a fixed f_c back to the transmit instrument. Any delay introduced in the return loop will be constant and can be zeroed out. The transmit instrument then can compare the phase of the retransmitted f_m envelope with the originally transmitted f_m. Envelope delay is expressed in microseconds and usually is given as microseconds more delay than the delay at 1800 Hz.

Envelope delay can be controlled by phase equalizers. It is tariffed parameter for C level conditioning. Figure 9 illustrates the C2 limits on envelope delay.

In the CCITT environment, phase shift characteristics are measured by a slightly different technique referred to as group delay. □

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Rolling, rolling, rolling, keep those telcos rolling!

A Telephony study examines the parameters of the vehicle fleets of the U.S. telephone industry—all the data fit to print

THE AFFILIATES OF American Telephone & Telegraph Co. (AT&T), New York, N.Y., the parent company of the Bell System, operate the largest private vehicle fleet in the U.S., according to a recently released study conducted by the Market Research Dept. of Telephony Publishing Corp., Chicago, Ill.

The U.S. telephone industry as a whole, including the nearly 1500 Independent telephone companies, operates nearly 260,000 vehicles, according to the study.

The study, *Vehicles in the U.S. Telephone Industry: A Stable Growth Market*, was made by Research Manager Dana Inan of Telephony Publishing. It costs $35 per copy.

The companies covered in the study serve 96% of all U.S. telephones. Some of the study's highlights are discussed below.

Bell on wheels

The Bell System's vehicle fleet contains approximately 40,000 automobiles, about 106,000 light trucks and vans, and more than 47,000 trucks which weigh more than one ton. The Bell System fleet thus contains more than 193,000 vehicles, 80% of which are vans, light trucks or heavy trucks.

As of the end of 1978, the Bell System's vehicle fleet represented a capital investment in excess of $1 billion. The estimated annual cost of fuel and repairs for the vehicles came to another $400 million.

"With such a large fleet, even a small savings per vehicle can make a sizeable total savings," the study says. "The Bell System operating companies, as do the larger Independents, have a number of computerized systems for fleet tracking and management."

The Bell System owns 99% of its vehicle fleet. However, the amount of maintenance work done by Bell System mechanics varies widely. Companies which operate in centralized areas, such as Illinois Bell Telephone Co. or New York Telephone Co., do almost all of their maintenance work themselves. Companies which serve less densely populated areas, and consequently have garages which are widely separated, tend to have outside agencies do more of their maintenance work; companies like Southwestern Bell Telephone Co. or Mountain States Telephone & Telegraph Co. fit this description. There are other factors besides the type of service area, such as garage capacity, which also affect maintenance decisions.

Affiliates of General Telephone & Electronics Corp. (GTE), Stamford, Conn., operate a fleet with about 35,500 vehicles, not counting vehicles operated by affiliates based outside the U.S. GTE companies, like Bell System companies, tend to own their vehicles. At GTE companies, like Bell System companies, "the decision of whether to perform maintenance and vehicle repair in-house or through local garages and dealers, and the mix, has a lot to do with the availability of these supports and the nature of the operating company's own serving area characteristics," the study says.

The companies affiliated with Continental Telephone Corp., Atlanta, Ga., operate a fleet of 8000 vehicles. Only about 500 of those vehicles are owned by the operating telcos. About 1000 of the vehicles are leased from a Continental Tel leasing subsidiary, and the rest are leased from other sources.

The study also contains information on the vehicle fleets of the other Independent telephone holding companies. Affiliates of United Telecommunications, Inc., Kansas City, Mo., operate a fleet of more than 8900 vehicles; the affiliates of Central Telephone & Utilities Corp. (Centel), Chicago, Ill., operate about 3000 vehicles; the affiliates of Mid-Continent Telephone Corp., Hudson, Ohio, operate more than 1600 vehicles; and the remainder of the Independent telephone industry operates more than 12,300 vehicles.

The study contains another interesting statistic. *All* of the vehicles owned by U.S telephone companies were manufactured in the U.S. This contrasts sharply with the success non-U.S. manufacturers have had in other sectors of the U.S. automobile market; their vehicles currently account for 25% of the U.S. market.

Besides compiling quantitative data, the study also contains information on future trends; for instance, there is information on why some companies are turning to vehicles with fiber glass bodies while others are not.

For more information on *Vehicles in the U.S. Telephone Industry: A Stable Growth Market*, contact Telephony Publishing Corp., Market Research Dept., 55 E. Jackson Blvd., Chicago, Ill. 60604; telephone: (312) 922-2435; telex: 910-221-1058.

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FIG. 1 *The Bell System dominates the other telcos when it comes to total number of vehicles.*